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A Seven-Day Journal

Maudslay Society

LAST Friday, the Maudslay Society held its annual luncheon at Whitehall Court in London, preceding its annual general meeting. The toast of "The Society" was proposed by Lord Brabazon of Tara, who remarked, amongst other things, in a lively and partly reminiscent speech, how great a thing the Society was doing in keeping green the memory of a great man. He energetically affirmed that there were as many great inventions still to be made as had ever yet been made, and that Maudslay's example in that respect should be an inspiration to young men to-day. The president, Mr. O. D. Smith, replied. The toast of "The Guests" was proposed by Mr. J. Foster Petree, president of the Newcomen Society, and Mr. G. W. Tookey replied. In his report for the year, presented at the meeting afterwards, the president remarked upon the fact that in the early days of the Society attempts were made to organise visits to manufacturing plants, but that travel difficulties caused by the war caused a suspension of these activities. He drew attention to a visit to the Maudslay Motor Company to be made on June 11th next He remarked also that one of his ambitions was to see established a permanent museum in which to have representative exhibits relating to the products of Henry Maudslay and his posterity. Last December he had had the pleasure of presenting the third Maudslay Scholarship of £125 to Mr. John Robert Weaver-Smith. Recently it had been agreed that the value of this scholarship should be increased to £150 for next year.

Launch of M.S. "Windsor"

THE name ship and prototype of a new class of five modern motor tramp ships, which are building for the Britain Steamship Company, Ltd., was launched on Friday last from the Clydeholm shipyard of Barclay, Curle and Co., Ltd., Glasgow. The ship was given the name of "Windsor" by Her Royal Highness the Princess Royal, who performed the naming ceremony. The ship has a length between perpendiculars of 435ft, a breadth moulded of 58ft 6in and a depth of 38ft to the shelter deck, and is expected to carry a deadweight of 9950 tons on a draught of 27ft, while the gross tonnage is approximately 7600 tons. The ship is powered by a four-cylinder oil engine of Doxford design, arranged to burn heavy fuel and developing 4400 b.h.p. at 115 r.p.m., to give the ship a service speed of 13 knots. Many innovations have been incorporated in the design to meet the particular requirements of the owners, and these include an engine-room ventilation system based on coal mine practice and weather deck ballast tanks to give greater control over stability. At a dinner given by the shipbuilders the chairman of Barclay, Curle and Co., Ltd., Mr. George Barrie, gave the toast of "The Ship and Her Owners." In the course of his speech he mentioned the early interest of the Watts family in shipping and went on to review the innovations incorporated in the ship. He stressed the many novel ideas introduced by Mr. E. H. Watts with a view to improving the efficiency and safety of the ship and the comfort of the crew, and particularly noted that the ship was of riveted construction, a significant fact when present-day trends were towards the all-welded ship. Mr. Barrie concluded by announcing that his company had received the order for another ship from the Britain Steamship Company, Ltd. In his response Mr. E. H. Watts, the chairman of the shipowners, recalled that the Princess Royal had launched an earlier ship and said that Her Royal Highness always sent presents to the ship at Christmas. He supported his ideas for the production of efficient ships and underlined the need for amending the regulations, which, he maintained, were out of date. Mr. Watts also proposed the toast of "The Builders" and mentioned the close collaboration between Barclay, Curle and Co., Ltd., and the Caledon Shipbuilding and Engineering Company, Ltd., the builders of the remaining four ships of the class. Mr. James Gilchrist, a director and vice-chairman of the builders, replied and mentioned that Mr. Watts had introduced some of his ideas into the engine-room, particularly with regard to reducing the number of tools required for maintenance.

The South Wales Institute of Engineers

THIS week the South Wales Institute of Engineers has announced that arrangements have been completed for the South-Western Society of Mining Engineers to amalgamate with it on July 1st. From that date members of the South-Western Society of Mining Engineers will be recognised as members of the South Wales Institute of Engineers. At the same time, the South Wales Institute is to become federated with the Institution of Mining Engineers. The South Wales Institute of Engineers, which has its headquarters in Cardiff, was founded in 1857, and was granted a Royal Charter of Incorporation in 1881. Throughout the years of its existence it has taken a full share in advancing and disseminating technical knowledge, and its members have made some important contributions directed towards diminishing the hazards of mining. The South-Western Society of Mining Engineers was formed some years ago to assist the advancement of the science and practice of the mining of coal and other stratified deposits and to encourage the education necessary for the control and direction of mining operations. For some time now it has been apparent that it would be advantageous for the two societies to amalgamate, and negotiations to that end were started several months ago. The Institution of Mining Engineers, with which the South Wales Institute is federating, has been in existence since 1889. It was established as a federation of much older district institutes, its objects being the advancement of knowledge concerning coal and iron ore mining operations.

The Need for Scientists

THE fifth annual report of the Advisory Council on Scientific Policy, which has just been published, gives the conclusions reached by the scientific manpower committee which began its investigations at the end of 1950. The committee states that no effort should be spared to meet the urgent need for more scientists in industry, particularly chemists, chemical engineers, electrical engineers, mechanical engineers and physicists. It is pointed out that even when the difference in the sizes of the labour forces in this country and the United States is taken into account, America is training nearly three times as many scientific workers as Britain. The current demand for scientists arising from industry, the defence programme, &c., is so great that the committee can see no prospect of the supply exceeding the demand for at least the next five years. The general conclusion reached was that there is likely to be a long-term shortage of practically every kind of scientist, although at present the supply of geologists, civil engineers and metallurgists appears to be equal to the demand. There is some unemployment of men trained primarily in the basic biological sciences, but there is simultaneously a shortage of biologists of the quality and training to fill a small number of specialised posts. The report says that it would be useful if the universities considered whether any changes could be devised in the general curriculum for biological studies, such, for example, as the introduction of more chemistry and physics, which would equip biology graduates for a wider range of employment than is at present open to them.

The Manufacture of Water Turbines in Scotland

ON Thursday, May 22nd, we attended a Press visit at the works of Harland and Wolff, Ltd., at Scotstoun, the object of which was to demonstrate the progress made there in the manufacture of water turbines. This work owes its origin to an approach made by the North of Scotland Hydro-Electric Board in 1947, when it was agreed that water turbines should be manufactured at the Scotstoun works to the designs of the English Electric Company. Many of that company's orders for hydro-electric machinery are now manufactured at Scotstoun, where, since 1947, fifty-seven large water turbines, twenty alternators and sixty-two steam turbine condensers have been built, both for Scottish hydro-electric schemes and for export. Of the many items of hydro-electric machinery in course of manufacture at the time of the visit, those of particular interest included a straight-flow turbine-inlet valve 11ft in diameter for a 62,000 h.p. turbine of the Castelo-do-Bode hydro-electric scheme in Portugal. This valve is the largest of its kind built so far; its construction is generally similar to the ones described in our issue of April 25th last, installed at Fasnakyle power station.

An Institute of Material Handling

A MEETING, held in London recently to discuss the possibility of forming an institute or association of material handling, was attended by about seventy people representing users and manufacturers of mechanical handling equipment, the manufacturers' representatives forming a small minority. At this meeting, which was under the chairmanship of Mr. John R. Sharp, a unanimous decision was taken to form an Institute of Material Handling. In addressing the meeting, Mr. Sharp said that of just over a hundred invitations sent out there were seventy acceptances, and all but two of those unable to be present were keen on the proposition. He stressed that the meeting had been called for by users and not manufacturers of equipment. Some institutions touched on the subject, but they did not specialise in material handling, and it was now felt that material handling should have a status of its own. With the proposed institute discussion groups could be formed where users could discuss their problems, and all forms of the technique of material handling could be reviewed. Mr. Sharp stressed that the institute would not be for trade or business objects, and there would be various classes of membership. Mr. Tom Mott, of Vauxhall Motors, Ltd., was appointed provisional chairman and Mr. John Bright, of Joseph Lucas, Ltd., provisional deputy chairman, with Mr. A. F. Much treasurer. A provisional council of sixteen members was also elected. We are informed that those interested in the new institute should apply for further information to the secretary, Mr. Maurice W. Paynter, A.C.C.S., 20–21, Took's Court, Cursitor Street, London, E.C.4.

Harvesting of Brown Sub-Littoral Seaweeds

No. I—ASSESSMENT OF THE PROBLEM AND REVIEW OF PRELIMINARY EXPERIMENTS

By PHILIP JACKSON, M.Sc., M.I.Mech.E., M.I.Chem.E., F.R.S.E.*

Machinery is being devised for the commercial harvesting of British sublittoral seaweeds. Two main principles are being investigated, namely, tearing the weed from the sea bed and raising it to the surface mechanically and cutting the weed from the sea bed and raising it by entrainment in water. In this, the first of a series of articles, the problem is reviewed and particulars given of exploratory experiments.

Introduction

THE first attempt to establish an industry in this country based on the organic constituents of its brown seaweed resources was made in 1934, since when a comparatively small, but growing, industry has developed for the extraction of alginic acid, one of the main constituents of the brown seaweeds. The source of raw material for this industry is, at present, cast seaweed, i.e., seaweed dislodged from the sea bed during storms and cast on to the beaches, where it is collected and spread on walls to dry to about 40 per cent moisture content before being transported to the factories for final drying and processing.

The present world production of alginic acid and its sodium and calcium salts is estimated to be about 4000 tons per year, which represents an annual consumption of fresh seaweed of about 140,000 tons. The total quantity of brown seaweeds growing between low water and 7 fathoms off the Scottish coasts has been estimated, from the results of a partially completed survey[1, 2] and aerial photographs,[3] to be in the region of 10,000,000 tons. Possibly only about 40 per cent, or 4,000,000 tons, of this is located where inshore shipping could reasonably be expected to operate and, of this reduced total, not more than 25 per cent should be harvested each year in order to conserve our seaweed resources. There is therefore a potential annual availability of approximately 1,000,000 tons for commercial exploitation.

Recent investigations by the Institute of Seaweed Research have been aimed at the utilisation of the three other potentially valuable organic constituents of the brown seaweeds, viz., mannitol, laminarin and fucoidin.[4, 5] Since, however, the exposure of cast seaweed to rain and bacteria on the beaches either removes or destroys these other chemicals, such a development is only possible when the physical and economic difficulties of harvesting fresh sublittoral seaweed from the sea bed have been overcome.

Two other factors militate against the use of cast seaweed as a source of raw material: (i) planned observations of thirty beaches in the islands of Lewis, North Uist, Tiree and Orkney over a period of two years have indicated that "casts" are inconsistent in quantity, time and place, and (ii), largely because of (i), the provision of high-capacity mechanical collecting equipment is not economically feasible.

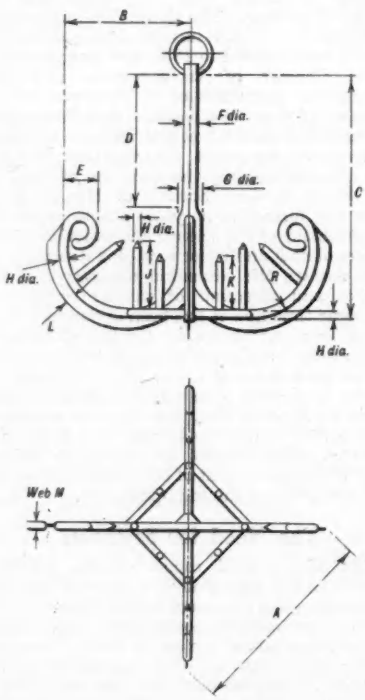
The solution of the sublittoral seaweed harvesting problem is therefore of prime importance in the future development of the seaweed industry.

The only information which appears in the literature on this subject relates to (i) the harvesting of floating seaweeds of the *Macrocystis* and *Nereocystis* types,[6, 7, 8, 9] a comparatively simple and completely different problem, (ii) patented designs of small scale harvesters,[10, 11] which are unsuitable for harvesting on a commercial scale, and (iii) first trials of a mechanical harvester for the frond (leaf) of the weed,[12] the development of which was stopped at the end of the last war.

Problem

The design of a continuous mechanical harvester that can override all the different kinds of obstacle encountered on the sea bed is a problem without precedent.

It must be capable of cutting or dislodging seaweed and raising it to the surface while operating over a bed of rocks, reefs and crevices of all shapes and sizes, calling for a high degree of flexibility to permit automatic adjustment to the constantly changing position of the gear on the sea bed, relative to the surface equipment, and to prevent transmission to the boat of the strains imposed by the pitching, rolling and side slipping of the structure carrying the cutting or dislodging mechanism.



Dimension	Grapnel No. 1	Grapnel No. 2	Grapnel No. 3
	Ft in	Ft in	Ft in
A	1 6	2 3	3 0
B	1 0	1 6	2 0
C	1 9	2 4	2 7
D	1 0	1 8	1 1
E	3	4½	6
F	1½	1½	1½
G	2¼	2¼	2¼
H	¾	¾	¾
J	6	6½	8
K	5	5½	7
L	1	1	1
M	⅜	⅜	⅜
R	6	9	1 0

FIG. 1—GRAPNELS USED IN FIRST SERIES OF EXPERIMENTS

Provision must be made to guard against damage by impact with boulders, by the wedging action of jagged rocks, or by anchoring; in extreme instances there is a danger that the equipment will be irreparably distorted or the whole harvesting gear lost and it may well be that before commercial harvesting can be undertaken on an extensive scale it will be necessary to survey the configuration of the sea bed in sufficient detail to indicate the position of, at least, the more dangerous obstacles.

The most practicable working depth is 4 to 5 fathoms, which is a compromise between (i) the depth of maximum density of growth, and (ii) a comparatively safe distance from the shore. Even at this depth there is a considerable risk of striking submerged rocks or reefs. Safe operation therefore demands quick and easy manœuvrability under constantly changing load conditions—a complete contrast to the comparatively ideal conditions of steady load for long periods under which deep sea vessels operate.

Serious difficulty is occasioned by the inherent tendency of seaweed to drape on any and every member of a structure drawn through it, and to cause "blinding" or jamming of the harvesting mechanism; this is particularly true of methods using static or moving cutters. One obvious solution is to cut the weed into small pieces, but this increases its susceptibility to bacterial decomposition and is therefore impracticable unless and until economic means of preserving wet seaweed are found. Also, some difficulty might be experienced in separating the resulting intimate mixture of small pieces of stipe (stem) and frond for subsequent drying and/or processing.

Two factors have an important bearing on the economics of harvesting. They are the high water content of the weed, which has been shown to vary between 75 and 90 per cent of the wet weight,[5] depending on the species, the season of the year and the depth of immersion, and the restriction of harvesting operations to periods when the weather conditions are favourable. Because of the close proximity of rocks it is difficult and unsafe to operate a seaweed harvester in anything approaching rough seas, strong sea swells or high winds. By operating off lea shores during periods of high wind it is possible to overcome this limitation to some extent, but it is, in any case, unlikely that harvesting will be possible in Scottish waters on more than about 200 days per year.

Investigation of the harvesting problem is not easy; it is difficult, if not impossible, to simulate sea bed conditions in an experimental tank, and development work, in general, can only be carried out at sea under operating conditions. While this procedure has the advantage that the results can be applied directly to the harvesting problem, it is a costly and time-consuming procedure with two serious disadvantages: (i) it does not permit visual observation of the experimental gear in operation, and (ii) it is impossible to experiment under standard conditions. In these circumstances it is necessary to carry out an unusually large number of experiments before the results can be accepted with confidence.

Because of the different physical characteristics of *Laminaria cloustoni*, *L. digitata*

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and *L. saccharina*,[12] the three commercially important species of brown sublittoral seaweed in Scottish waters, it is unlikely that a single machine can be designed to operate equally effectively in the harvesting of all three species. It is important, therefore, to design for the harvesting of the predominating species.

The experimental work and discussions recorded in this paper relate to the harvesting of *Laminaria cloustoni*, the predominating species of seaweed in the Scottish sublittoral zone.

Basic Principles of Harvesting

Two main principles of mechanical harvesting have so far been evolved and are being investigated in various forms. The first takes advantage of the inherent tendency

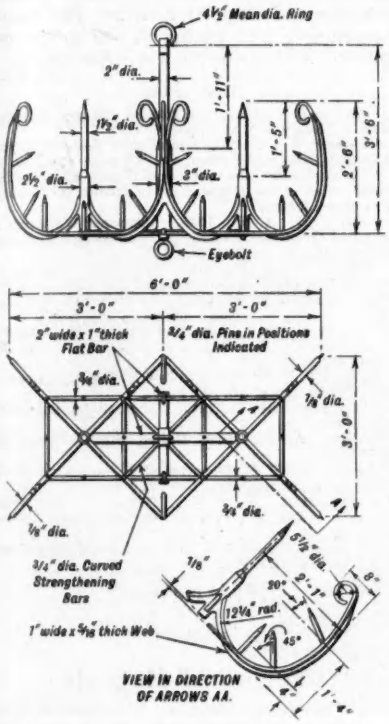

FIG. 2—GRAPNELS USED IN FIRST AND SECOND SERIES

of seaweed to drape and employs hooks to tear the weed from the sea bed and raise it to the surface mechanically. The second relies on severing the stipe about 6in above the sea bed and raising the cut plants to the surface by entrainment in water.

Equipments operating on the former principle have the advantages of simplicity and low initial cost; they are less liable to break down due to weed draping and jamming the moving parts, and, in any case, damaged parts are quickly and easily replaced.

The cutting and entrainment principle, on the other hand, permits a lighter and more flexible construction and is possibly more suitable, therefore, for operation from small boats in coastal waters; an equipment operating on this principle is less liable to damage the weed and, by reason of its cutting action, to harvest foreign matter.

It is, however, fairly certain that both principles will have useful application in the widely varying conditions under which commercial harvesting must ultimately be carried out.

The Grapnel Principle

With the object of obtaining fundamental information on the most suitable form of hook for tearing the weed from the sea bed without anchoring or damage, the forces involved in dragging equipment over the sea bed and the effect of speed on the efficiency of operation, this principle was first investigated in its simplest possible form—by dragging grapnels of various shapes and sizes from small power-driven boats.

Three series of experiments were carried out in the areas indicated below:

(i) Kerrera, Mull, Port Appin, Cullipool and Ardencaple Bay, off the West Coast of Argyll.

(ii) Shapinsay, Westray and Papa Stronsay, in the Orkney Islands.

(iii) Ardencaple Bay, Argyll.

These experiments are described and the results recorded and discussed below.

Experimental Equipment and Procedure

The grapnels* used in series (i) are shown in Figs. 1 and 2, the latter being similar in design to the former, but of a size to cover a 6ft width of track on the sea bed. They were operated from a 30ft motor boat, powered by a 30 h.p. engine. Because of the lack of hold capacity in this boat and in order to permit continuous operation, a second and similar boat was used to transport the harvested weed to the shore.

The weed was weighed on a 5 cwt spring balance slung from the derrick head of the harvesting boat. During the dragging operation the strain in the tow wire was measured by a second 5 cwt spring balance, shackled to the towing bar, which also absorbed the towing shocks.

During the early stages of the Orkney experiments—series (ii)—grapnels of a similar design were again used, but were subsequently modified (Fig. 4) to suit the apparently more severe sea bed conditions in Orkney. The boat used was an ex-Admiralty T.R.S.B., 60ft long by 14ft 6in beam by 3ft 1in mean draught, powered by two 100 h.p. Perkins diesel engines. A three-speed Edwinson winch incorporating two working drums and two running bollards was installed aft of the wheelhouse and was belt-driven from the port engine. Two 8½in by 10ft long wood derricks were fitted for raising and discharging the loaded grapnels, but it was subsequently found to be more suitable and safer to operate from two davits at the stern of the boat (Fig. 3), which were manually operated through worms and pinions. The illustration shows one grapnel loaded with *Laminaria cloustoni* plants and the other swung out ready to drop to the sea bed. Two carpenters' stoppers fitted with tension springs capable of absorbing the towing shocks, and shackled to the deck bits aft, provided a simple and efficient means of securing the tow wire. A 2-ton spring balance was slung from the derrick head for weighing the loaded grapnels.

The same equipment was used in the final Ardencaple Bay experiments — series (iii).

In the preliminary experiments two marking buoys were dropped along a line parallel to, and some distance off, the shore, to mark the extent of the weed bed. The grapnel was then dropped overboard, the tow line secured to the 5 cwt spring balance, and a drag of about 75 yards carried out at slow speed within the limits defined by the marking buoys. The loaded grapnel was raised from the sea bed by means of a hand-operated winch, weighed on the spring balance at the derrick head, and the weed discharged into the carrier boat for transporting to the shore.

In Orkney and the final Ardencaple Bay experiments the procedure was modified (*a*)

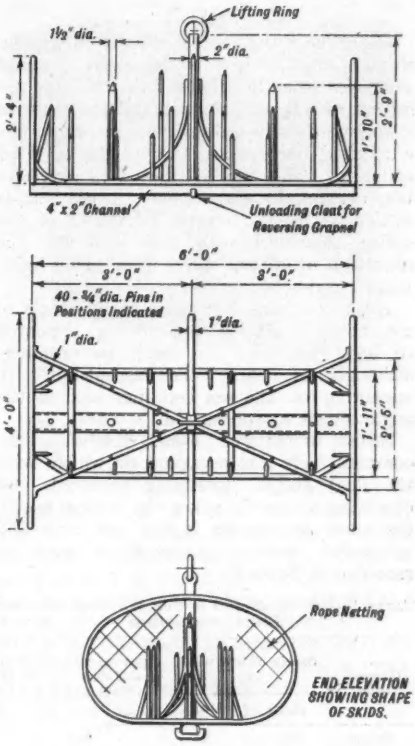

FIG. 4—MODIFIED GRAPNEL FOR ORKNEY WATERS

for two-grapnel operation, and (*b*) because the hold capacity of the larger boat eliminated the necessity for a second boat to transport harvested weed to the shore. In addition, the drags were measured on a time basis instead of the distance basis used in the previous experiments. The grapnels were operated intermittently, one being dragged along the sea bed while the other was being off-loaded into the ship's hold. This procedure was followed until the hold was full, when the boat proceeded to shore where the

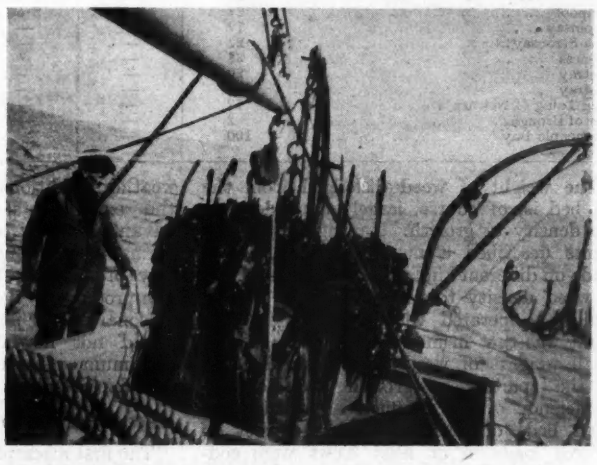

FIG. 3—GRAPNELS OPERATED FROM STERN DAVITS

weed was discharged. The following data were recorded during the experiments :—

(1) Weight of seaweed collected at various speeds and over various lengths of drag.

(2) Depth of water.

(3) Strain in tow wire.

(4) Times for all operations in the complete cycle.

(5) Weight of foreign matter adhering to the weed.

(6) Direction of tide and general weather conditions.

Results

Operating Speed.—Most effective operation was obtained with a towing speed of about 1·8ft per second. Above 2·5ft to 3·0ft per second with the 3ft grapnel (and at somewhat lower speeds with the smaller sizes) there was a marked decrease in the weight of weed collected. This was attributed to excessive bounding of the grapnel over the sea bed, as evidenced by the erratic behaviour of the spring balance in the tow wire and the reduction in critical speed when using light-weight grapnels.

Angle of Tow.—Variation in the angle of tow between 10 deg. and 20 deg. appeared to have no effect on hook performance, although, of course, the susceptibility to anchoring on the sea bed increased as the angle of tow was decreased.

Strain in the Tow Wire.—Excluding the comparatively rare occasions on which, with the final design, anchoring occurred, and operating at speeds below the critical speed, the measured strains in the tow wire and calculated power consumptions were as recorded in Table I :

Table I—*Recorded Strains in Tow Wire and Calculated Power Consumptions*

Grapnel size	Strain in tow wire (lb)		Approx. max. grapnel power consumption at 1·8ft/sec (h.p.)
	Max.	Min.	
1ft 6in	224	84	0·8
2ft 3in	280	112	1·0
3ft 0in	392	168	1·3
6ft 0in	—	—	—

Capacity.—The average weights of seaweed dislodged per drag in the various test areas are given in Table II :

Table II—*Average Weights of Seaweed Dislodged per Drag*

Area	Number of drags	Average weight per drag in cwt			
		1ft 6in grapnel	2ft 3in grapnel	3ft grapnel	6ft grapnel
Shephards Hat, Kerrera	24	0·42	0·70	—	1·26
Grass Pt., Mull	24	0·54	1·06	—	1·16
Port Appin (S)	18	1·04	2·32	—	3·12
Port Appin (N)	24	1·58	1·98	—	1·98
Cullipool	24	1·92	2·50	—	4·28
Shapinsay	17	—	—	2·44	—
Papa Stronsay	22	—	—	1·68	—
Treenes	38	—	—	1·42	—
Westray	20	—	—	0·16	—
Westray	254	—	—	3·92	—
Long Taing of Newark	17	—	—	0·40	—
Ness of Brough	2	—	—	3·00	—
Ardencaple Bay	100	—	—	4·00	—

The weight of weed dislodged from the sea bed is, of course, largely dependent on the density of growth. During the experiments described a number of drags were made on different kinds of sea bed irrespective of weed density to prove that the grapnel could be operated without damage. The result was that in many of these drags very small weights of weed were raised because of the sparcity of growth and not the inefficiency of the grapnel. In continuous weed beds of reasonably high density of growth loads of at least 5 cwt were consistently raised per drag.

Although the primary object of these experiments was to obtain data for use in the development of a continuous mechanical harvester, the intermittent grapnel has been proved to be, in itself, a simple and effective means of harvesting sublittoral seaweed under reasonable weather conditions. In common with other possible methods at present envisaged, its operation becomes more difficult as the weather conditions deteriorate and, of course, impossible in winds approaching gale force. It has the advantages, however, of simplicity, low initial cost and maximum flexibility. It has been proved over many hundreds of experimental runs that grapnels of suitable design can be operated on most, if not all, kinds of sea bed without appreciable damage.

The main disadvantage of the method is its low capacity. The maximum size of grapnel for use from a small boat has been reached and has been shown to have a capacity of 10 to 15 tons (wet) per day, or about 1000 to 3750 tons per year, depending on the number of days suitable for harvesting, the density of weed growth and the nature of the sea bed. These quantities, useful as they are, would not be adequate to maintain a very large industry, and it is obvious that efforts to devise a high-capacity mechanical method must continue.

The operating costs, during the experimental runs, varied between £0·78 and £2·55 per wet ton. After experience in large scale harvesting, and by a careful choice of harvesting area, the maximum use of mechanisation and possibly the use of a larger boat, it should be possible to operate consistently at the lower end of the range. Discharging the weed ashore by hand, for instance, was found to be laborious and time-consuming, and could undoubtedly be speeded up and simplified by the use of nets spread in the carrier boat to receive the weed from the grapnel. These and many other improvements which would inevitably result from experience in large-scale operation, would effect substantial reductions in the costs of harvesting seaweed by this method.

The experiments have clearly indicated the economic importance of harvesting on the maximum number of days per year and, in this connection, the use of a larger boat, with a larger hold capacity, which would be able to operate in more severe weather conditions than was possible during the experiments, would be of obvious advantage. To confine harvesting to the spring and summer months would be one way of ensuring the minimum number of non-productive days and would enable a seasonal labour force to be employed. This would not however cover the period of max mum concentration of all the potentially valuable chemicals in the seaweed.

Mechanisation of the Grapnel System

The first attempt to mechanise the grapnel system was based on the use of a power-driven continuous chain with grapnel members fitted at regular intervals throughout its length, and an automatic stripping device for off-loading the weed into the holds of the harvesting boat.

To prevent anchoring it was necessary to provide intermediate supporting skids, arranged in such a manner as to raise the leading edge of the following grapnel members when an obstruction was encountered. The excessive weight necessary to resist the fairly high bending and twisting moments to which the grapnel members and these intermediate supporting skids are subjected in operation is perhaps the greatest drawback to such a system.

This drawback has been overcome in an alternative arrangement which permits the use of a much lighter form of hook and the elimination of the offending heavy grapnel members and supporting skids. The design, construction and testing of the prototype* unit will be described in a separate article.

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(*To be continued*)

Technical Reports

Gas-Blast Circuit Breakers : A Preliminary Study of Arc Form and Movement in a Single Axial Blast Experimental Model (Ref. G/XT131). By F. Oliver Mason, B.Sc. (Eng.), A.M.I.E.E. The British Electrical and Allied Industries Research Association, Leatherhead. Price 15s.—This report deals with some preliminary results obtained from an examination of the top gap in an experimental axial blast breaker, by the use of a rotating drum camera with a slit aperture. The photographs show that the arc form changes fairly abruptly from a diffuse to a more determinate form as the gas pressure in the reservoir exceeds that necessary to obtain the velocity of sound in the throat. Above this pressure the arc takes on a vigorous circulatory motion, at least during the period of lower current values, which can be roughly pictured as tracing out the surface of a cylinder whose axis is concentric with the axis of the electrodes. Schlieren photographs of cold flow above the throat, and "still" pictures of the arc from exposures during the whole of the arcing period, show marked correlation in both form and relative light intensity with the photographs obtained with the rotating drum camera. A section dealing with the significance of "arc diameter" as portrayed by photographic technique is included.

Series Breaks in Circuit Breakers : Some Factors Affecting Accuracy in Recording the Distribution of Restriking Voltage (Ref. G/XT137). By F. O. Mason, B.Sc. (Eng.), A.M.I.E.E. The British Electrical and Allied Industries Research Association, Leatherhead. Price 7s. 6d.—This report forms a preliminary to the investigation into the voltage division occurring between series breaks in a circuit breaker. It deals entirely with the errors that may be introduced by the recording arrangements, and details a method for ensuring that they are kept to a minimum.

* Patent applications have been submitted to cover the equipments described in this article.

British Industries Fair

No. V—(*Concluded from page 692, May 23rd*)

IN the concluding article of this series we describe some of the exhibits we inspected at the Castle Bromwich section of the Fair which closed on Friday, May 16th.

B.I.P. Engineering, Ltd.

A new hydraulically operated horizontal pelleting machine was shown with the range of "Bipel" auto-control moulding presses on the stand of B.I.P. Engineering, Ltd., of Aldridge Road, Streetly, Staffs. This machine (illustrated in Fig. 49) is intended particularly for producing pellets about 2in diameter weighing from 1·2 oz to 2·8 oz.

The hopper of the machine is mounted on the die block *A*, as can be seen in the diagram in Fig. 50. In the position shown—the start of the pelleting operation—the powder flows down into the space between the fixed punch *B* and the moving punch *C*, attached to the

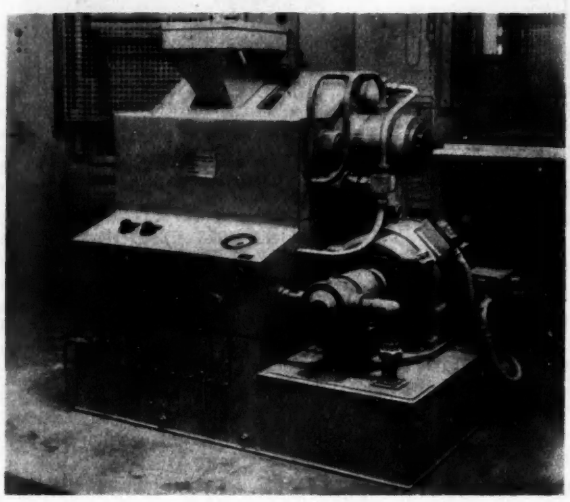


FIG. 49—PELLETING MACHINE—B.I.P.

hydraulic ram. The die and the hopper are then moved to the left, leaving the gap between the punches full of powder entrained in the bore of the die. The hydraulic ram then comes into effect to force the moving punch towards the fixed punch and compress the powder in the die to form the pellet. At the end of this compressing stroke the die and hopper move further to the left in the fixed punch and, as the moving punch is retracted the pellet falls out of the die into the discharge chute. The cycle of operations is completed by the die and

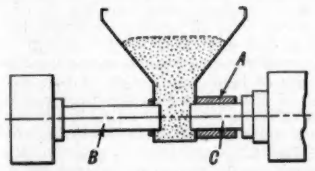


FIG. 50—PELLETING MACHINE OPERATION B.I.P.

hopper moving back to the reloading position shown.

The pressure ram makes only sufficient movement to compress the powder and the only other effort required is that of pellet ejection, which is quite small. Through the pneumatically operated control gear five controls are provided—time delay for varying pressure dwell on the pellet, weight control, pressure control, dwell at filling, and dwell at ejection. The two last-mentioned controls are rarely required, although bad powders with a large proportion of fines sometimes need adjustment at the filling end.

The maximum hydraulic pressure of 3000 lb per square inch required on the pelleting ram during the squeeze is obtained from an intensifier; the working pressures for movements in other parts of the cycle are stated to be under 200 lb per square inch. The pressure on the ram is variable between 10 and 35 tons.

Nuway Manufacturing Company, Ltd.

A matting which was originally introduced for domestic purposes, but which is now widely used in industrial and commercial establishments, is that made by Nuway Manufacturing Company, Ltd., of Coalport, Shropshire. This matting is made in several forms for different applications, some of which were shown on the company's stand at Castle Bromwich.

The matting consists essentially of series of fibred rubber links woven together by a wire which is selected according to the duty for which the mat is intended—to resist corrosion, chemical attack, &c. It provides a hard wearing surface which has good non-slipping properties, whether wet or dry. The matting is made in standard sections which can be fitted with end or side clips to facilitate connection when it is required to cover large areas.

The matting can be used to replace duck boards in factories, as a floor covering where edge tools or machined parts are liable to damage when dropped, on vehicle platforms, and on ramps and gangways used by both vehicles and pedestrians.

Standard Telephones and Cables, Ltd.

"Common Diagram" remote control equipment, "Sentercell" rectifier equipment arranged for high-voltage cable testing, and power factor correction equipment, were among the exhibits shown by Standard Telephones and Cables, Ltd., Connaught House, Aldwych, London, W.C.2.

Power factor correction was demonstrated on a bank of capacitors totalling 150kVAr, 400V, three-phase, arranged to give fully automatic correction. This apparatus showed by means of meters and a display panel the improvements obtainable through the use of shunt capacitors on industrial distribution systems. The demonstration was designed on a base load of 100kW and indicated directly the reduction in kVA and the power factor improvements obtained by connecting various values of capacitance throughout a range of initial power factors. The way in which automatic correction operates to give the maximum improvement was also demonstrated.

Our illustration (Fig. 51) shows a bank of five 30kVAr capacitors, each of which em-

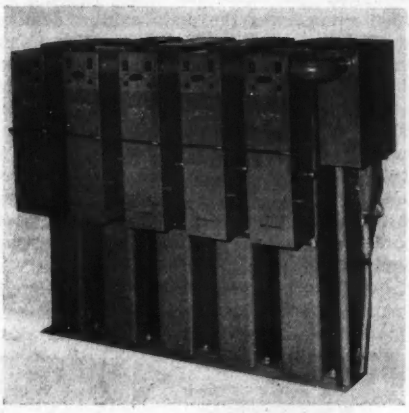


FIG. 51—BANK OF 30KVAR CAPACITORS —STANDARD TELEPHONES

bodies an individual built-in control unit consisting of an air-break contactor, and isolator, fuses, control switches and indicating lights. The isolating switch handle is interlocked with the control unit cover so that the latter cannot be removed until the equipment is isolated. By the addition of further 30kVAr units the capacitor bank can be extended economically to cope with any future increases in load which might call for increased correction capacity.

B. O. Morris, Ltd.

Automatic polishing machines for all classes of work, as well as flexible shaft machines, are made by B. O. Morris, Ltd., of Briton Road, Coventry, and a recent addition to this line of products is the twin brushing machine illustrated in Fig. 52. Two models of this machine are made

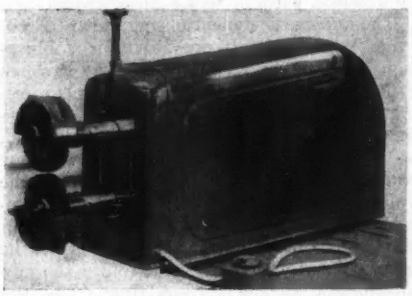


FIG. 52—TWIN BRUSHING MACHINE—MORRIS

They are similar in all respects except that one is fitted with brushes set 4in from the front of the casing, whereas on the other, the brushes are 14in in front.

The brush spindles are driven by a 3 h.p. motor at 2880 r.p.m., and they are designed to take brushes or mop from 3in to 6in diameter and 2in wide. The top brush spindle is mounted in a slide adjustable vertically through a screw. During polishing the brushes retain the workpiece, which the operator only has to guide as there is no

tendency for the piece to be pulled into the brush.

The driving motor is controlled by a foot switch on which pressure must be maintained for continuous running. Whilst the machine is running variation of brush pressure on the workpiece is obtained by altering the angle of feed.

ELECTRIC CONSTRUCTION COMPANY, LTD.

A self-synchronising and automatically regulated motor-alternator set, running at 1500 r.p.m., was the main exhibit demonstrated by the Electric Construction Company, Ltd., Wolverhampton.

The set consists of the following units coupled in tandem: a 6·5 h.p., three-phase, 50 c/s, 415V induction motor; a 6 h.p. d.c. machine rated at 31·4/36A, 170/148V; a 3·4kW single-phase, 50 c/s, 240V alternator; and an exciter rated at 5·1A, 31V. A direct-on starter for the motor and a control cubicle and rectifier for the set completes the equipment (Fig. 53).

Regulation of the alternator voltage is effected by an "Eccareg" regulator, which is a static equipment based on a similar principle to that of the magnetic amplifier. The set demonstrated maintains the voltage to within ±2 per cent, but closer limits can be attained without major modification.

The automatic synchronising unit ("Eccosyne") employs only one valve for stabilisation purposes and can be used as a check synchronising unit or as a direct synchronising unit. It compares the voltage and frequency of the alternators to be paralleled and, at the same time, checks the rate of frequency changes between the two sets. Providing the voltage of the two alternators is within preset limits, and the frequency change between the two is at a sufficiently slow rate, then the unit will automatically synchronise the two alternators at the correct time. As the voltage difference and the rate of frequency change between the alternators can readily be adjusted the units are adaptable to any size alternator.

Alternators up to 1000kVA can be paralleled directly by the automatic synchronising unit, while with larger alternators it is recommended that the unit should be used as a check synchronising unit, although the makers state that the unit would parallel the machine automatically.

The unit is arranged so that, in case of failure of any component, automatic synchronising could not take place and indication would be given of this failure.

Automatic speed control of the set when driven by the d.c. motor is achieved by an "Eccodyne" electronic control unit, which maintains the speed within ±1 per cent. The regulator receives a signal from a tachometer generator coupled to the end of the shaft of the main machine, and regulates the speed of the d.c. motor by field control. This electronic regulator is built so that in case of failure of any component part the machine would shut down and ample warning would be given.

The two regulators and the synchronising device are built into a composite control unit to control the motor alternator set demonstrated.

One or more sets can be used to provide a continuous alternating current supply for telecommunications, essential power services, &c. Under normal circumstances the set is driven by the a.c. motor from the public supply system. The alternator provides constant voltage/frequency supply for essential services. The d.c. machine floats across an emergency battery and maintains the battery in a fully charged condition. On failure of the a.c. supply the d.c. machine drives the set from the battery at controlled speed so that the alternator maintains constant voltage and frequency. It maintains constant output with the battery voltage varying from 180V to 100V, i.e., from full charge to full discharge.

On resumption of the public supply the a.c. motor again drives the set, the alternator still provides the essential supply, but the d.c. machine, running as a generator, recharges the battery and floats across it in the fully charged state. A continuous a.c. supply is therefore provided, irrespective of public mains failure, power cuts or abnormal frequency variation of the public supply. A number of sets can be used and paralleled together at will as the essential supply requirements increase or for servicing. Paralleling is carried out automatically by the synchronising unit, without any interruption or disturbance of the emergency supply.

The three controlling units—regulator, synchronising unit and electronic speed control unit—can be used independently or as a combined unit for the general control of alternators and d.c. motor-generator sets.

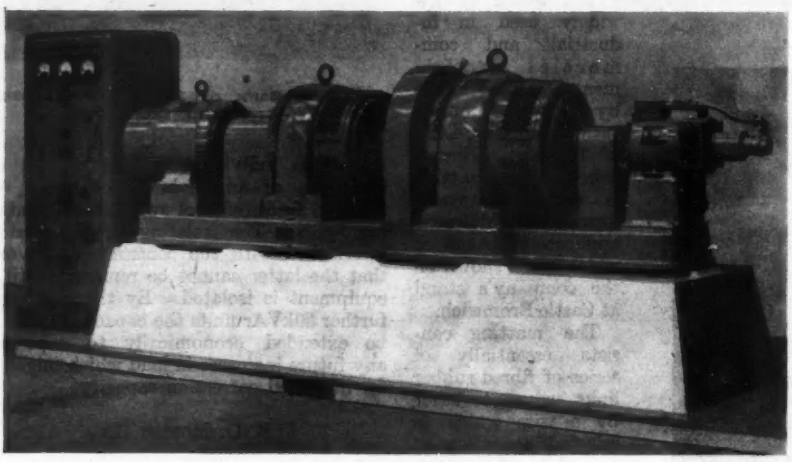


FIG. 53—MOTOR ALTERNATOR SET—E.C.C.

AEROX, LTD.

The products of Aerox, Ltd., of Glasgow and Crawley, were grouped roughly into four main sections on the firm's stand. In these groups were shown "Porsilex" media for aeration, filtration and diffusion; "Celloton" electrolytic media as diaphragms for electrochemical processes; filters for air, gas and liquids, and special diffusion and aeration equipment.

A 6ft 6in aerating tank exhibited was equipped with three different grades of "Porsilex" aerators and controlled from a switchboard fed with compressed air. Demonstrations given with this tank showed the capacity of the media for different purposes. The stainless steel filter vessel shown in Fig. 54 has a 2ft diameter chamber and contains thirty-one 12in long ceramic elements. It is designed for handling large volumes of gas or liquid up to working pressures of 100 lb per square inch. With a media having a pore size of 100 microns it can give a flow of 75,000 gallons per hour when operating on water at 25 lb per square inch, depending, of course, upon the percentage of impurities present.

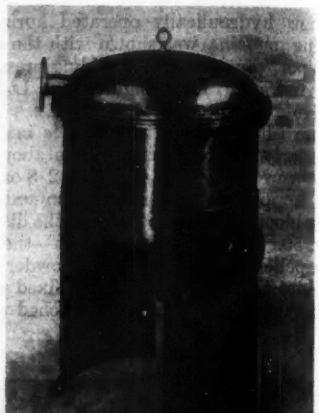


FIG. 54—FILTER VESSEL—AEROX

Codes of Practice

STREET LIGHTING: PART I, TRAFFIC ROUTES

Code CP. 1004: 1951. This code is one of a series issued jointly by the Institution of Electrical Engineers and British Standards Institution. It is designed to develop the recommendations made in the final report of the Ministry of Transport Departmental Committee on Street Lighting (H.M.S.O., 1937) and deals with traffic routes only, i.e., roads classed in the report as Group A. Another part of the code (in preparation) will deal with lighting for other routes. It explains what allowances should be made, when the lighting of a given road is planned, for prevailing conditions, e.g., volume and type of traffic, layout and nature of the road and its surface, boundary conditions, &c., in order that the required level of lighting expressed in lumens per linear foot of route may be secured. Recommendations are made, for various circumstances, on the choice of light distribution (cut-off fittings or non-cut-off fittings) and on the spacing of lanterns. The use of either electricity or gas is envisaged, but electrical and gas installation practice is outside the scope. Particular attention is given to considerations governing the placing of lanterns and advice is included on methods of marking out a site. Recommendations are made for maintaining the performance of installations. Appendices set out the information which should be supplied by inquirers (when tenders are invited) and with tenders. The text is illustrated by numerous drawings, including diagrams of typical sites. Copies of the code may be obtained from the British Standards Institution, Sales Department, 24, Victoria Street, London, S.W.1, price 4s. post free.

Iron and Steel Institute

No. IV—(*Concluded from page 710, May 23rd*)

On Thursday morning, May 1st, there was a joint discussion on two papers entitled :—

MEASUREMENT OF AIR INFILTRATION IN OPEN-HEARTH FURNACES

By R. Haynes, B.Sc.

Synopsis

The paper describes the direct measurement of air flow, in furnace uptakes and in the culverts below the checkers, using a water-cooled Pitot static tube. Generally, infiltration is found between the culverts and uptakes at low air flows, and air is lost between them when the fan speed is high.

AERODYNAMIC FACTORS ASSOCIATED WITH THE WEAR OF OPEN-HEARTH FURNACE ROOFS

By J. A. Leys, B.Sc., and E. T. Leigh

Synopsis

The wear of the roof of an oil-fired open-hearth furnace has been investigated by examining the flow conditions existing in a model of the furnace. The causes of the wear are discussed and are concluded to be associated with : (*a*) high-velocity streams, in which combustion may be taking place, impinging on the surface, giving a very high temperature and possibly reducing conditions ; and (*b*) deposition of slag particles from such streams as they turn sharply.

It is shown that the technique of comparing the flow distribution and the deposition of particles from the furnace atmosphere on to the roof of a model of the furnace, with the regions of heaviest wear in the furnace itself, indicates the location and intensity of erosion, so that means of reducing it in the model may be applied to the actual furnace.

The steps suggested to minimise wear are : (i) the maintenance of the burner direction forward of the furnace centre line, if possible ; (ii) the use of a single air port ; (iii) the use of a vertical back wall instead of the more usual sloping type.

The most important factor is control of the burner direction.

Dr. A. H. Leckie (Head of Steelmaking Division, B.I.S.R.A.), who presented the first paper, said that Mr. Haynes had now left B.I.S.R.A. to join the atom scientists. Since the paper was written a great deal of additional work had been done, and would be reported in due course.

Discussion

Mr. M. W. Thring (B.I.S.R.A.) : When open-hearth operators are arguing together there are three things that they talk about, at any rate when they are discussing open-hearth furnaces : output in tons per hour, fuel in tons or therms per ton, and refractories, usually in shillings per ton. I want to draw a diagram showing how these two papers are related to those three things. On the left I want to put the fundamental factors from which these things arise, and they are, in my opinion, the theoretical flame temperature (TFT), the heat transfer factors (HT), and the aerodynamic factors (AD). The theoretical flame temperature in turn depends on the fuel used and pre-heat temperature, and the excess air. On the heat transfer side we have the flame emissivity, convection and insulation of the furnace, which we do not talk about if we can help it. On the aerodynamics side we have the flame length, about which we have been talking earlier to-day, the flame position, and the impact of the flame on surfaces.

Roughly, it can be said that the first set of factors affect output and fuel economy primarily, while impact is the main factor affecting refractories consumption. From that diagram I also draw the conclusion that until excess air is properly measured and controlled on the open-hearth furnace there can be no fair comparison between two furnaces. It is no use saying "My port design is better than yours, because I get a better fuel consumption and better output," when you have good control of excess air and the other man has not, and that is the real difference between your two furnaces. Until we have regular measurement of preheat and regular measurement of oxygen in the downtakes the comparison of open-hearth furnace port design and other things will always be upset and erroneous conclusions will be drawn, because these things are essential to get the maximum possible flame temperature and therefore the greatest output and the best fuel consumption. Mr. Haynes's paper is a challenge to those who build open-hearth furnaces, and the main conclusion is that it is time that we designed an airtight open-hearth furnace somewhere or other.

The paper by Leys and Leigh is concerned primarily with the question of impact, and therefore refractories, and the model technique is quite a suitable one for that purpose. The situation with an open-hearth furnace is that you have a jet bouncing on the steel surface, and naturally it bounces up and impacts on the roof and on the outgoing ramp and erosion takes place there. It is very interesting to find that the place where solid particles are thrown out of the model is the place where erosion occurs. That suggests that if we knew more about the mechanism of erosion we could take the models even further. I have for a long time wondered whether it would be useful to build our models of salt for the inside surface, to replace the silica bricks, and put a water spray in with the fuel stream and get the water particles dissolving the salt away, measuring the contours of erosion by running the model for a certain time to see whether we could get still closer comparison with the real furnace.

Mr. R. Whitfield (Incandescent Heat Company, Ltd.) : Some years ago I supervised the building of a glass tank—to go away from open-hearth furnaces, for a change—and on one side I persuaded the client to let me try a practical, long-date experiment. I coated one side with silicate of soda in two coats, applied hot, while the other side was left as built. Monthly readings were taken and thermometers were placed in relatively corresponding positions and readings taken every month and then averaged, and at the end of twelve months we examined the position. On the coated side we started off with 108, which, owing to the coating, went up to 110. On the other side we started at 108 and gradually climbed at the end of twelve months to 128. Taking into account the radiation and convection factors with which you are all familiar, there was obviously a big difference between one temperature and the other which showed itself in the temperatures of the flame. I think, therefore, that the silicate of soda method or any other method is worth trying to seal the outside. At the end of twelve months corresponding bricks were taken out and sectioned and put under the microscope. It was found that the silicate of soda had penetrated to approximately $\frac{3}{16}$in to $\frac{1}{4}$in, while on the uncoated side dust had gone in to the extent of $\frac{3}{4}$in or $\frac{7}{8}$in and then petered out. That accounted, to my mind, for the difference in temperature, because the porosity of the insulating refractories, which consisted of 9in refractories and 9in insulation, had been destroyed. I think, therefore, that this is well worth trying.

In many cases we can do with a balanced atmosphere and therefore reduce the infiltrated air to a minimum. That infiltrated air must affect flame temperature and so on. Working it out roughly from a quantitative point of view, and assuming that the infiltrated air is 10 per cent, which is quite an average figure, that has to be raised to approximately 1700 deg. Cent., which accounts, theoretically at any rate, for a good 100 lb of coal, assuming that 1 ton of coal gives 150,000 cubic feet of gas, and the air ratio is 1·2. I think, therefore, that it is worth trying a seal method of some kind, not necessarily entirely to eliminate the infiltrated air, because you may want it, but to have control of it. It seems to me that the trouble which we all meet with is that we cannot control this infiltrated air.

Mr. J. W. Till (John Summers and Sons, Ltd.) : We know from the paper given to the Institute by Dr. Chesters on flow patterns in furnaces, as well as from a similar paper by Mr. Howes at Ashorne Hill, that the model technique, properly calibrated and carried out, will correlate with what is found on the actual furnace, and Mr. Leys has emphasised that again to-day with regard to particle deposition. The results on the model of particle deposition and the location of areas of severe wear on the actual furnace did tie up exactly, and, following suggestions obtained from the model results with regard to the alteration of burner angle, back wall and single air uptake we were able to modify the furnace structure and reduce the effect of the deep gouge along the back wall.

For other reasons, mainly combustion, we were not able to do very much with the burner, which Mr. Leys has emphasised is critical, but we were able to straighten out the back wall. We have not made it vertical ; obviously as steelmakers we know that that has an effect on output. That, however, was the main modification which we made, and it did succeed in reducing the severe wear. Wear still occurs there, as it must from the type of furnace, but it is not the deep gouge that we were getting formerly, and we are able to put in a hot patch over the week-end, and that gave us at that time a roof life of twenty-eight weeks. Subsequent rebuilds of the furnace caused us to merge the two uptakes and produce virtually a single-uptake furnace—not a true one, but near enough—and that has maintained the improvement in roof life ; in fact, a roof life of thirty to thirty-three weeks, including the patch, is not unknown.

Mr. S. Kruszeuski (United Glass Bottle Manufacturers, Ltd.) : Dr. Leckie has mentioned that with certain pressure conditions in the furnace the metered rate of flow of air may be higher than the true rate of flow in the uptakes. We work at high pressures in our furnaces. We are fortunate in having no doors to be opened ; the feed of raw material is mechanical and the furnace is nearly sealed. The pressure at the glass level is about 0·05in to 0·1in w.g. We are working, therefore, in conditions of fairly high pressure in the furnace, and our common experience—in fact, our much too common experience—is, as Dr. Leckie found, that the metered rate of flow upstream of the air reversing valve is higher than the amount of air getting to the furnace. We did several tests on this, and we are definitely of the opinion now that the cause is the leakage of the air valves.

Mr. M. P. Newby (B.I.S.R.A.) : The results obtained by Mr. Haynes depend very much on accurate gas velocity measurements, and such measurements are extremely difficult to carry out when the gases are at high temperatures. This is a problem which remains to be solved, to invent a new kind of instrument to measure such velocities.

We have a few ideas, but have not yet managed to get anything to the practical working stage. Because of this, we are still relying on pitot tubes, although we are not sure whether they are quite good enough for high-temperature measurements. Dr. Leckie mentioned that we are building a hot wind tunnel to calibrate pitot tubes under high-temperature conditions, so that we are quite sure that we know how they are behaving. At Battersea at present we are building up a simple but large piece of apparatus in which we are burning town's gas and producing a high-temperature stream of gas in a known section of a tunnel, measuring its temperature and the quantity flowing, so that we know its velocity accurately, and that will enable us to calibrate our tubes. We do not think that there is much discrepancy between the behaviour of water-cooled tubes at low temperatures and at high temperatures, but we do not know what the actual discrepancy is until we have measured it, and so I hope that in a few months' time we shall be able to give a definite answer to this question of technique.

At the final session of the meeting on Thursday afternoon, May 1st, the discussion was based on the following papers :—

DETERMINATION OF HYDROGEN IN LIQUID STEEL

By R. M. Cook, B.Sc. (Eng.), and J. D. Hobson, B.Sc.

Synopsis

A comparison between two methods for the determination of hydrogen in liquid steel is given as a result of collaborative work between two laboratories. The methods employ a sealed mould and a quenched notched pencil, which have been developed in the respective laboratories. Results are given for fifteen casts made by acid and basic open-hearth and basic electric-arc processes, and sampled at the works with which the authors are associated. Satisfactory agreement is shown for comparative results obtained by the two methods.

DIFFUSION OF HYDROGEN IN IRON AND IRON ALLOYS AT ELEVATED TEMPERATURES

By P. L. Chang, B.Sc., and W. D. G. Bennett, B.Met. (Hons.)

Synopsis

The effects of chromium, nickel and molybdenum on the rate of hydrogen permeation in iron have been investigated. Chromium has little effect on permeation in the γ range, but greatly reduces the rate of permeation in the α range. Nickel and molybdenum have little effect.

The permeation equation has been re-examined; experimental evidence leads to a general equation:

$$P = k_1 p_1^x (1-S) \exp\left(-\frac{E}{RT}\right)$$

where P is the rate of permeation per unit area, p_1 the ingoing pressure, and T the absolute temperature; x and S are functions of temperature such that $\frac{1}{2} < x < 1$, and $0 < S < 1$. The equation given by Richardson,

$$P = K p_1^{\frac{1}{2}} \exp\left(-\frac{E}{RT}\right)$$

may be considered as a limiting case of the more general equation in which $x = \frac{1}{2}$ and $S = 0$. The variations of x and S from these values in certain circumstances are attributed to slow phase-boundary processes.

When $x \simeq \frac{1}{2}$ and $S \simeq 0$ the phase-boundary processes are believed to be fast compared with diffusion through the metal, and a time-lag method for determining D, the diffusion coefficient, has therefore been used. The values of solubility calculated from the data obtained are of the same order of magnitude as those obtained by different methods.

DISTRIBUTION OF HYDROGEN IN LARGE INGOTS AND FORGINGS

By J. D. Hobson, B.Sc., and C. Sykes, D.Sc., F.R.S.

Synopsis

The distribution of hydrogen in several cores trepanned from large ingots and forgings has been investigated. It is shown that severe segregation occurs, and persists in finished forgings. The variation found depends upon the size of sample, being much more severe with small specimens. Rehydrogenation experiments demonstrate that segregation is not caused by variable hydrogen solubility. Some practical implications of the results are considered.

EFFECT OF HYDROGEN ON THE PORPERTIES OF LOW-ALLOY STEELS

By J. D. Hobson, B.Sc., and C. Sykes, D.Sc., F.R.S.

Synopsis

A method is described by which hydrogen is introduced into steel specimens by heating them in the gas at high pressures. The deleterious effect of hydrogen on the ductility of a number of low-alloy steels has been investigated and shown to be reproducible, provided that their heat-treatment is also considered. Hydrogen additions have the same effect whether carried out by electrolysis or by the high-pressure technique.

Discussion

Dr. L. Reeve (Appleby-Frodingham Steel Company): It is symptomatic that, of the three major elements in which we used to take so much interest in the early days of work on gases and non-metallics, the original emphasis, when we began dealing with the subject seriously about twenty years ago, was on oxygen, with a lesser emphasis on nitrogen, but the practical aspects of gases and non-metallics seem now to be favouring hydrogen as the most important of these three elements. That, of course, is illustrated in the last two papers of this series of four, and also in other directions, in particular in connection with hydrogen in weld metal As far as the first paper is concerned, on the determination of hydrogen in liquid steel, I should like to mention two small points which are of interest and which have arisen in our own experience in applying this method in our works. One small but interesting point is that it is generally implied that these samples taken from liquid steel and kept in dry ice should be examined within twenty-four hours. As a matter of practice, in applying the method to the determination of hydrogen in a heat of steel or a series of heats throughout the day it is often not convenient, with one analyst and one hydrogen apparatus, to do the work in twenty-four hours, and sometimes it is nice to be able to keep the samples for several days. We have found that by careful storage of the box of dry ice in which the samples are stored, putting it into another suitable, well-insulated container, the loss of hydrogen which occurs even after seven days, 168 hours, is surprisingly small. The samples can safely be kept for two or three days, provided due care is taken in the container. Another small point is that we found that the particular pencil specimen described in this paper is a little too small in diameter and, if the steel sample which is being poured happens to be on the cold side, there is a danger of cold shut being formed in the sample, which leads to the sort of error mentioned by the authors of the fourth paper; one gets voids down the centre of the specimen and abnormal results. We have increased the sample diameter from $\frac{1}{4}$in to $\frac{5}{8}$in with markedly improved results. We find that the ordinary carbometer test specimen makes a very nice pencil specimen if quenched very quickly in the usual way, but we either use old moulds or deliberately increase the diameter to $\frac{5}{8}$in.

On the second paper, I shall not pretend that I am competent to discuss the diffusion of hydrogen, and I take the mathematics for granted. I take it that in due course we shall get, and in fact we already seem to have, the necessary information to calculate actual diffusion rates in fairly large masses of steel, but that is not definitely discussed in the paper. There is one small point which perhaps the authors can clear up. There is a reference to anomalous behaviour of the Armco iron specimens—they are called "Armco iron" in one place and "ingot iron" in another. Was this particular heat of ingot iron, the details of which are given in broad outline, deoxidised ?

The paper on the distribution of hydrogen in large ingots and forgings in particular, with its implied conclusion that relatively small voids will make a very big difference to the distribution of hydrogen, and will therefore explain the segregation results which the authors observed, is very interesting to me, because I have done some work, and presented a paper to the Institute which created, I believe, some controversy, on the influence of the degree of oxidation of a steel, or rather of a weld, on its hydrogen content. Those who read that paper may remember that, apart from the influence of iron oxide itself in solution, I referred to the possibility of voidage, in the sense of spaces round inclusions and other small voids, as being a factor in determining the difference in so-called diffusible versus total hydrogen content. In those cases where voids may be present there will be a tendency for hydrogen to enter those voids and become non-diffusible, and it will only be obtained, therefore, subsequently in an ordinary high-temperature hydrogen extraction. The present authors seem to find that there is a marked variation in the hydrogen distribution in these large forgings, which, they suggest, may be due to the influence of voids, and their results have an obvious relationship to the point which I made.

The final paper is again one of considerable interest to me. It provides the background information to explain what is well known in most test shops in this country, that if there is any doubt about ductility or elongation of the test specimen it is wise to put off the test for as long as possible. It is known definitely that where there is marginal ductility, and one is satisfied that the ductility may be "a bit tight," quite marked improvement in the reduction of rejects from that cause is obtained if one keeps the steel to be tested for a reasonable period before submitting it to the test. We have always assumed that this is due to hydrogen. We know that in the case of ordinary carbon steels large specimens of that kind, if kept under mercury for a period of weeks, and even months in the case of the larger specimens, are still giving off gas which is substantially hydrogen, and in that case, no doubt, the improvement in ductility is due to the same phenomenon as is reported in this paper.

Mr. D. R. Wood (Mond Nickel Company, Ltd.): The history of metallurgists' attempts to evaluate the effects of gases in steel goes far back to the beginnings of steel metallography, and therefore many advances in our understanding of the subject have been made. There is still a measure of confusion in some people's minds about the specific effects of individual gases, but the sort of work which is described in these four papers extends our knowledge appreciably. Hobson and Sykes have put forward evidence to confirm earlier impressions that, while a simple relationship exists between average hydrogen content and ductility, no such relationship exists with hairline cracking, and the implication of the results quoted in their two papers seems to be that segregation of hydrogen is a more significant factor affecting hairline cracking than is average hydrogen content. It would therefore appear to follow that the hydrogen content of the molten alloy is insufficient evidence on which to predict the formation of hairline cracks on processing.

Considering the effect of hydrogen on

ductility, it is surprising at first sight to find that the relationship between average hydrogen content and reduction in area is both simple and reproducible, in view of the marked segregation of hydrogen which has been shown to occur. If segregation causes erratic hairline cracking, why does it not cause ductility measurements to be similarly erratic? The explanation may be that cracking requires what we may term activation, such as would be involved in the production of molecular hydrogen in pores, whereas ductility, except in severe cases in which it is also associated with cracking, is dependent on atomic hydrogen in solution and is therefore controlled by diffusion. As long as diffusion is the controlling factor, uniform distribution of hydrogen would be expected, together with a simple, reproducible relationship between hydrogen content and ductility. When segregation occurs, erratic results would be expected. It may be possible, therefore, that what we have termed activation controls cracking, and that under similar conditions of activation a relationship may exist between cracking and average hydrogen content for any given composition of steel.

Mr. J. E. Russell (English Steel Corporation, Ltd.): I have two questions to ask on the paper by Chang and Bennett. In the isobars which the authors obtained from the Armco iron which they show in their Fig. 3, did they ever repeat those reheating cycles, particularly from 940 deg. Cent., a number of times, and in fact more than twice? They obtained repeatable results on reheating and cooling from 400 deg. and 420 deg. Cent., but obtained erratic results after reheating to 940 deg. Cent. It seems to me possible that if they had soaked for a long time at 940 deg. Cent., or continued to give cycles of reheating, they might eventually have come down to a sort of equilibrium curve, because of the scavenging action of the hydrogen at that high temperature. I wonder whether they analysed their samples after these reheating cycles, because it is almost certain that there would be some reduction of the initial carbon content after such high- temperature soaking. Incidentally, have they any explanation of the fact that on the 10 per cent molybdenum alloy as well as the high chromium one, with over 4 per cent chromium, the divergence from the straight line occurs at the higher temperature and not the lower one, starting about 600 deg. and upwards? Is that due merely to sluggishness in the gamma to alpha transformation, and, if so, does that indicate that full equilibrium conditions were not reached in their permeation experiments, as they claim?

Mr. J. D. Hobson (Hadfields, Ltd.): The most striking thing about the paper by Chang and Bennett is the deviations from the theoretical straight line which occur round about 400 deg. Cent. or slightly lower. In the work which we did at Firth's we found no such deviations on three alloy steels which we investigated, nor did other workers who worked with a similar apparatus and who also worked on Armco iron and alloy steels, and who got straight lines with no variation. The American workers Ham and Rast got these low-temperature deviations and attributed them to some previously unknown change-point. It seems to me a common factor in whether or not you get deformations.

Mr. G. T. Harris (William Jessop and Sons, Ltd.): I have only one small question to ask. It relates to the paper by Cook and Hobson, in which the authors refer to a certain deoxidation practice of the metal sample in the spoon before pouring their pencil samples. It is our experience that this gives no trouble for the final sample just before tapping, but it is possible to get considerable errors at an intermediate stage in the heat. They refer only to the use of a small quantity of aluminium wire for killing. Some figures which we took of hydrogen determinations through the course of a heat gave values which were so low, of the order of 2·5 ml., that we thought that they could not be right, and so we took a sample from a nickel-chrome-molybdenum steel at first slag-off and deoxidised it with an excess of aluminium. The hydrogen value came to 2·4 ml., and, using instead an excess of ferro-silicon to deoxidise, the value came to 2·3 ml. Using 0·02 per cent of aluminium the value came to 5·6 ml., which was fairly obviously much nearer to the true value. I am interested to know whether the authors have fully explored the amount of aluminium necessary, because the difference between 0·02 per cent and an excess of aluminium depends on the state of deoxidation of the heat at the time, and it seems that tests taken during the course of a heat have to be viewed with great caution.

Brief replies by the authors concluded the proceedings at the meeting.

Gear Design and the Revision of British Standard 436

By D. B. WELBOURN, M.A.

PROFESSOR TUPLIN has recently made a powerful plea in these columns for the simplification of the design procedure in Part 4, so far as the proportions of gear teeth are concerned, when B.S. 436 is revised. May attention also be directed to the simplification of Part 7, which is concerned with the strength of gears?

The designer who is not continually engaged on gearing work can hardly hope to discover rapidly from B.S. 436 the basis on which he is expected to stress his gears, nor how small alterations in his general machine design—which so frequently take place in the later stages—are likely to affect their rating. Matters would be greatly simplified if the various factors being considered were to be listed individually and less attention were to be paid to unjustifiable niceties of design.

The fundamental nicety that might well be discarded is zone factors for spur gears. If precision ground gears are still to be allowed adjacent pitch errors of more than half a thou., it is clear from calculation and tooth deflection measurements published by Walker* and others that two teeth cannot share the load, and it would be more honest to calculate for the simplest condition of two teeth in contact at the nominal pitch point. Zone factors might be introduced as a bonus for gears finished to higher standards of accuracy, such as are produced to-day by a few firms.

From this point the gear design should be built up from the fundamental question of the real tooth load, composed of the nominal tooth load and the dynamic tooth load, the latter to be based on a combination of experience and Professor Tuplin's† analysis of the effect of pitch line velocity and elasticity. The new Standard should thus begin Part 7 by showing the designer how to estimate the magnitude of his real tooth load, and making clear the effect of altering the variables at his disposal, thus leading not merely to standardised design, but to good design.

The gear teeth can fail due to (i) breakage, (ii) scuffing or thermal loading, (iii) pitting, (iv) wear, the degree of seriousness of the failure generally being in that order; with zone factors gone, it will normally only be necessary to check the smaller wheel for its ability to withstand each of the above dangers, with a resultant simplification of the present procedure.

Consider tooth breakage first. Starting from the estimate of real tooth loads, a family of curves plotting real tooth load against *DP* for differing numbers of teeth will give direct readings of *DP* for some nominal S_b. The basis on which such curves should be drawn will doubtless be fully argued, but let the formula be given in the Standard as well as the curves. That it can be simple is shown by the widespread Continental use of Bach's formula.

Scuffing, pitting and wear all appear to be lumped together in the present Standard, but it would be more rational to try to separate them out, and while doing so at least to give consideration to the large volume of work published in the last few years in the *V.D.I.Z.* and elsewhere by Niemann and Glaubitz‡, where evidence is adduced for believing that pitting obeys the normal laws of fatigue and that wear is a separate function of a complex nature. When considering wear, credit might be given for the fitting of efficient filters in the oil system.

In view of the heavy argument which continues on the subject of scuffing and thermal loading factors, the revisers of the Standard may be forgiven if they fight shy of it; but reference to any Continental design pocket book will normally show that Hofer's formula for thermal loading is at least considered to be useful when designing high-speed gears.

It is no purpose of this article to try to give suggested design rules for the Standard, but merely to make a strong plea that the new one, when it appears, should be lucid and simple in use, and that that simplicity should be attained by stating the factors to be considered, stating briefly the basis on which those factors are to be evaluated and then providing formulæ and charts for doing so. Should anyone believe that this cannot be done, they should consult a copy of Dubbel's *Taschenbuch für den Maschinenbau*, Vol. I. *Fas est ab hoste doceri!*

THE NEWCOMEN SOCIETY.—The summer meeting of the Newcomen Society is to be held in the East Riding of Yorkshire on Wednesday, Thursday and Friday, June 4th, 5th and 6th, with headquarters at Young's Hotel, High Petergate, York. The programme begins with a reception by the Lord Mayor of York at the Mansion House, on Wednesday evening, June 4th. On Thursday there are to be visits to York waterworks, the works of Cooke, Troughton and Simms, Ltd., the Castle Museum, and the Railway Museum, with the annual dinner of the Society at the Royal Station Hotel in the evening. On Friday, June 6th, the tour will include visits to Welton and Skidby, Springhead (Kingston-upon-Hull) pumping station, and to the shipyard at Hull of Cook, Welton and Gemmell, Ltd. The Society has announced its decision to publish as a memorial volume to the late Dr. H. W. Dickinson the series of articles from his pen entitled "Water Supply of Greater London," which appeared in THE ENGINEER between July and December, 1948.

* Walker, H.: 1938, THE ENGINEER, Vol. 166, page 434.

† Tuplin, W. A.: I.Mech.E., WEP. 59, *Proc.*, 1950, Vol. 163.

‡ Niemann, G., and Glaubitz, H.: 1950, *V.D.I.Z.*, Vol. 92, No. 33; 1951, *V.D.I.Z.*, Vol. 93, No. 6; 1951, *V.D.I.Z.*, Vol. 93, No. 9.

International Conference on Large Electric Systems

No. I

The fourteenth biennial meeting of the Conference Internationale des Grands Reseaux Electriques (C.I.G.R.E.) is being held in Paris from May 28th to June 7th. This conference was founded in March, 1921, under the ægis of the International Electrotechnical Commission and its purpose is to assist technical progress in high-tension electric systems by meeting for discussion every two years. Between the biennial conferences continuity is maintained by seventeen international study committees. The 1950 conference was attended by 1252 delegates representing forty-two countries.

THE inaugural ceremony of the conference took place at the Fondation Berthelot on Wednesday, May 28th, under the presidency of a representative of the Ministry of Industry and Commerce.

To allow more time for discussion at the technical sessions the total number of papers has been reduced to 120, compared with 144 in 1950. These papers are being presented and discussed at twenty-five sessions, some of them simultaneously.

The technical sessions opened on Wednesday afternoon, when two groups of papers, dealing with alternators and telecommunications interference, respectively, were presented for discussion. On Thursday morning the discussion on alternators was continued, while another session, held simultaneously, was concerned with teletransmission. The afternoon was devoted to papers on circuit breakers and this subject is being continued to-day, Friday, while a simultaneous session will be discussing insulating oils and insulators.

Alternators

Five of the twelve papers on alternators were the outcome of work done in the past two years by the generator study committee under the chairmanship of G. Balfils, who summarises these papers in a report (No. 133) presented to the conference.

In the first of these papers (No. 126) Giovanni di Vito (Sta Ercole Marelli) examined the choice of voltage and windings for large generators and discussed, with a view to standardisation, the effect of a rigidly fixed voltage on the cost and size of alternators. Assuming a range of standard voltages, in which the ratio between successive steps is less than 2 : 1, the author concluded that any required machine could be wound to the nearest standard voltage without appreciably increasing the cost compared with that of the voltage associated with minimum cost.

In another paper (No. 135) concerned with fundamental design problems, O. Hess (Brown-Boveri) made a study of the choice of constants —moments of inertia and damping reactance— for synchronous machines driven by water turbines. To reduce the acceleration time *Ta* the author suggested that greater use be made of a voltage regulator depending on the frequency, and that the auto-regulation of the network on ohmic load should be increased. He also proposed that the overspeed attained when full load is thrown off should be limited to 50 per cent.

The operation of turbo-alternators under unbalanced loads or out-of-step conditions was considered by A. Wust (Société d'Electricité de l'Escaut) and J. Dispaux (Electriques de Charleroi) in a paper (No. 106), which set out to determine the permissible duration of these abnormal conditions without causing damage, particularly to the slot wedges of the damper windings and to the adjacent insulation. The paper included tables giving the authors' results arranged so as to give some guidance on relay settings to provide protection against this kind of fault. A comment made by the generator study committee apropos of protection pointed out that there are no unbalance relays capable of discerning with certainty an inverse current of 8 per cent, and this matter is therefore commended as suitable for study by the C.I.G.R.E. committee on protection.

Deterioration of alternator windings through thermal expansion and contraction of the windings during intermittent operation was one of the problems discussed by W. D. Horsley (C. A. Parsons and Co., Ltd.) in his paper (No. 119) on the operation of synchronous plant. Troubles due to rotor coil deformation have been largely eliminated by designing modern machines for shift operation, but other remedies have had to be sought in the case of older machines. Mr. Horsley pointed out that some operators have been successful in preventing coil shrinkage by preheating the rotor windings before bringing the set up to speed, whereas other users have failed to remedy the defect by preheating. He went on to say that, to be successful, any such remedy must ensure that the same temperature gradients will be established in the rotor before running up, as those that obtain under maximum load conditions at speed. Engineers who favoured preheating and measures to maintain alternator temperatures when coming off load recommended the shutting off of air coolers and separately driven fans preparatory to off-loading the sets. Alternatively, it was possible to shut off the water supply to the air coolers and to keep the external ventilating fans running after the main set had been shut down ; the fan losses would then maintain the alternator temperature. It was considered that further information on preheating and similar expedients would be useful. In the meantime the author felt that the only certain method of minimising rotor coil shrinkage was to reduce the temperature gradients in the winding by limiting the rotor current and, therefore, the load, or improving the power factor. Another possible remedy was to rewind the rotor with hard-drawn silver-bearing copper.

In the fifth paper (No. 127), presented on behalf of the C.I.G.R.E. study group on generators, T. Stromberg and N. Knudson (A.S.E.A.) considered the subject of voltage stability with and without voltage regulators. They examined the behaviour of the synchronous machine feeding capacitive loads, such as long, lightly loaded transmission lines, and recalled the conditions for voltage stability : first, when the machine excitation is fixed or manually controlled the capacitive impedance must be greater than the direct axis synchronous reactance *Xd* ; and secondly, when the voltage is automatically controlled the capacitive impedance must be greater than the quadrative axis synchronous reactance *Xy* of the alternator. After considering the effect of saturation and the damper windings, the authors showed that, if the voltage is stable at the steady state, it will generally be stable under transient conditions.

Teletransmission

An experimental study of transient interference from power line faults on carrier current equipment was described in a paper (No. 303) by H. Elmlund (A.S.E.A.), S. Engström (Telefonaktiebolaget L.M. Ericsson) and A. Hollner (Swedish State Power Board). Circuit breaker operation or faults in a power network cause interference with high-frequency equipment connected to the power line. The disturbance is usually transient, but if the high-frequency circuits are connected to protective gear arranged for selective switching of faulty lines, the interference may cause maloperation of the protective device. In their paper the authors reported on investigations of this kind of disturbance on the Swedish power system. These investigations showed that disturbances caused by a power line fault need not affect operation of the protective apparatus provided that certain precautions are observed in the design of the relay system and the high-frequency apparatus. The received signal should be kept as high as possible so that it will not be blocked by strong disturbances : two-phase transmission is therefore advantageous, and the receiver sensitivity should not be allowed to increase when the signal disappears.

Another aspect of the same subject was presented by Henryk Kuhn (State Institute of Telecommunications, Warsaw) in a paper (No. 312), discussing the influence of power lines on h.f. telecommunication. This paper is the concluding contribution to a series (No. 309/1948 and 316/1950) discussing, at previous C.I.G.R.E. meetings, the problem of disturbances in h.f. telecommunication over power lines caused by faults in those lines. The earlier papers were concerned with the effects of faults such as bilateral earthing of one conductor and of all conductors on a three-phase power line. The present paper deals with the effect of unilateral one-conductor and three-conductor earthing for breaks involving both one and two conductors ; a break of all three conductors, with simultaneous earthing of all the broken conductor ends, is also considered.

Experiments carried out jointly by the Swedish State Power Board and the Swedish radio and telephone systems formed the basis of a paper (No. 323) on radio transmission on 220kV lines in Sweden, by S. Parding and C. A. Enstrom (Swedish State Power Board). This paper described a new method, called "line radio," of reducing radio interference from high-voltage lines. "Line radio" involves the transmission of a radio programme directly from the line causing the disturbance ; the line then acts as a transmitting antenna. The transmitter described in the paper was housed in the Ange switching station and was connected to each of the 220kV busbars through a 0·017 μF capacitor, an h.f. choke being connected between each capacitor and earth to by-pass the 50 c/s current. Each busbar was connected to two 220kV lines (Midskogsforsen-Västeras and Stadsforsen-Hallsberg). The transmitter output was 250W, frequency 182 kc/s, 80 per cent amplitude modulation.

A particular use of high-frequency transmission on high-voltage power lines was described in a paper (No. 337) by A. Chevalier and R. André (Electricité de France). This application of carrier-current remote control relates to the important overhead line connection between the power station at Chastang (with two, later three, 90MVA generator sets) and the 225kV switching station at Breuil, 12·5 miles away. To minimise the chances of failure of the carrier current system use was made of the phase comparison principle for the transmission of the signals essential to safety ; the main items of equipment (transmitters, receivers, relays, coupling apparatus) being duplicated. Finally, a switch capable of producing a three-phase short circuit to earth at the high-voltage terminals of each transformer was installed at Chastang. The sole function of this switch is to act as an overall safety device : if an "order" given by the protective gear at the power station fails to be transmitted to the switching station the short-circuiting switch operates and produces a system fault which causes the circuit breaker to be tripped by the protective equipment installed at Breuil.

Radio Interference

A short account of the measurements of radio noise on the British 275kV experimental transmission line was given by Dr. J. S. Forrest (Director, British Electricity Research Laboratories) in a paper (No. 301), which also covered measurements of power loss on the same line. Radio noise from the line was measured in the frequency range 0·1 to 30 Mc/s and, under the worst weather conditions, the noise intensity

was found to be about 10 db higher than that from existing 132kV lines. At distances more than 100m from the line the noise proved to be of the same order as that originating from other sources of interference. At very high frequencies interference was found to be negligible on sound channels; but with television, because of the wide band-width and the need to maintain line and frame synchronisation, interference would be possible under unfavourable conditions if the signal strength were low. Nevertheless the author showed that, in good conditions, a television picture free from interference could be received with the aerial only 10m from the 275kV conductors.

Experimental researches on the h.f. oscillations generated by the operation of each anode of a grid-controlled rectifier were described in a paper (No. 314) by Professor E. Gerecke (Zurich Polytechnic). In the course of this work oscillographic records were obtained of the oscillations transmitted and of the input and output signals on a radio receiver. The interference was also measured as a function of the load and the grid control angle of the converter and of the receiver wavelength. These records showed that, at the firing and extinction of the anodes damped transient oscillations of less than 200 kc/s were produced in the heavy current circuits. They produced, in the input oscillatory circuit of the radio receivers, damped transient voltages at about the natural frequency of the oscillatory circuit. The paper showed that the interference could be reduced by the use of suitable filters.

A theoretical study of the propagation of h.f. interference from industrial and domestic apparatus and a method of measuring the interference, formed the subject of a paper (No. 328) by L. Blok (Philips Eindhoven). With the help of a newly defined parameter called "propagation impedance" the author put forward a theory governing the relationship of the h.f. earth current of the generator and the electromagnetic field strength. He went on to discuss the possibility of checking the interference level of pieces of electrical apparatus by measuring the h.f. earth current, instead of the more complicated task of measuring field strength. In conclusion he made proposals for checking the theory and for deciding on the measuring instruments that should be used.

To provide a break from the technical sessions two technical visits have been arranged for this afternoon (Friday). The first is to the research and testing laboratory of Electricité de France at Fontenay. This interesting establishment includes a switchgear testing station which is equipped for carrying out tests on circuit breakers when connected directly to the 220kV networks of Electricité de France. The station, which was opened in November, 1949, enables comparative tests to be made on modern 115kV and 220kV circuit breakers under actual service conditions in the French high-voltage systems. With the help of transformers at present under construction it will be possible to extend the tests to operating voltages up to 380kV.

The facilities at Fontenay also include a high-voltage cable testing station, where comparative trials are now being conducted on six different designs of 220kV cables, as well as on a number of modern 63kV cables.

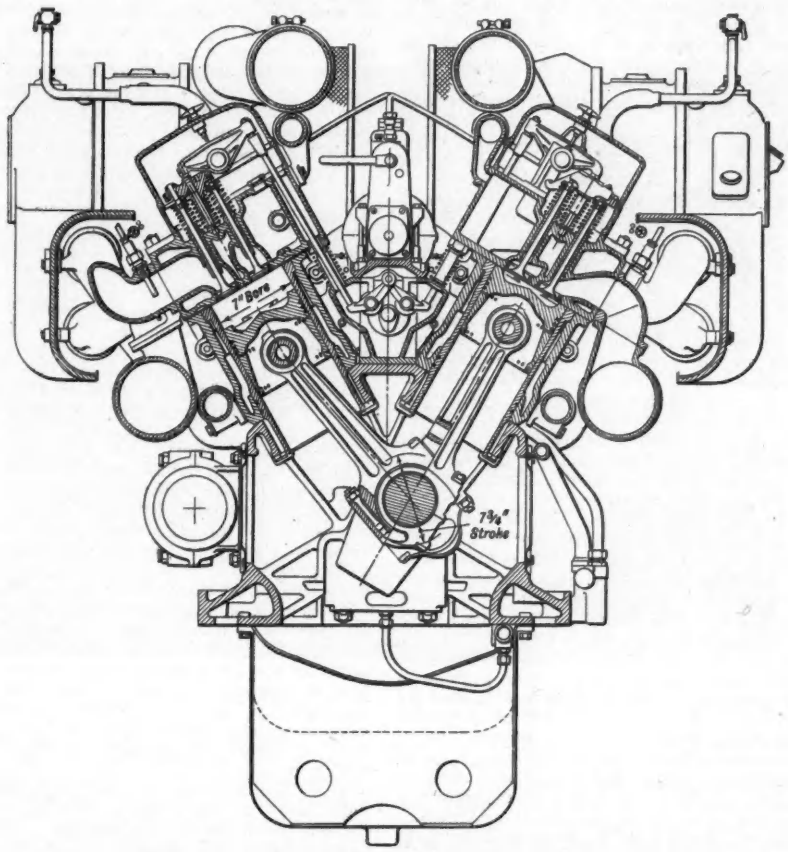
A more recent development at Fontenay is the inauguration of a new extra-high-voltage testing laboratory equipped with a 3000kV impulse generator, an installation for power frequency testing at voltages up to 1000kV, and an "artificial climate" room, in which tests can be carried out under controlled atmospheric conditions.

The second technical visit is to the Central Laboratory of Electrical Industries, which was opened in 1949. It houses the French National Standards and its main functions are to carry out high-precision and commercial measurements and tests as well as to prove the quality of materials and electrical apparatus, including dielectrics, magnetic sheet, insulating oils, radio components, wires, and cables. It is well equipped for investigating the effect of extreme physical conditions on electrical materials and apparatus.

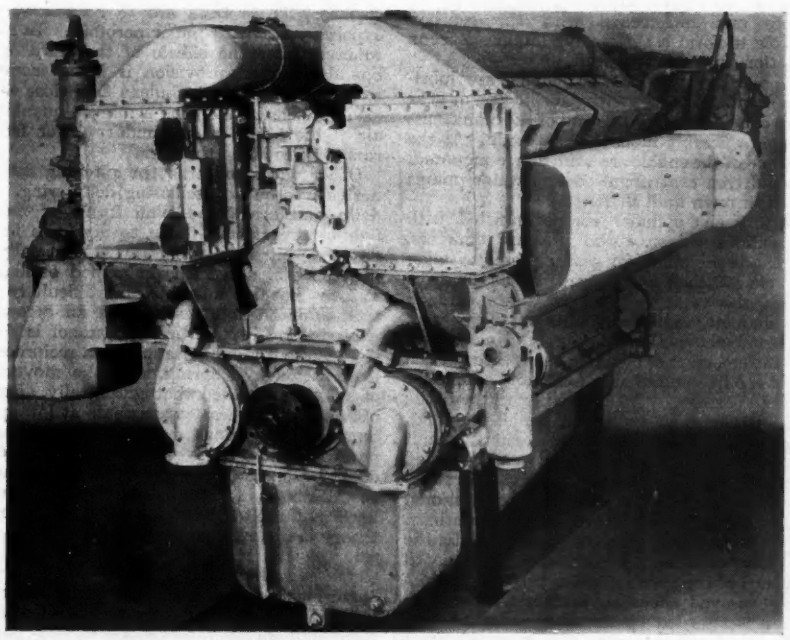
(To be continued)

Admiralty Standard "Range II" Engine

THE sizes of diesel engines which are required by the Admiralty, and which are designated Admiralty Standard Range II, range from 200 b.h.p. to 800 b.h.p., and to meet its needs for these particular engines the Admiralty has adopted a vee design engine, having a bore and stroke of 7in and 7¾in respectively, which has been developed by Davey, Paxman and Co., Ltd. Many major components of the engine are of aluminium alloy, but the considerable saving in weight has not affected the ability of the engine to give long periods of service. The new Mark YHA engine is now in production at the works of the designers and is being built under licence by Ruston and Hornsby, Ltd., and Ransome, Sims and Jefferies, Ltd. In the accompanying photograph we illustrate a twelve-cylinder



CROSS SECTION THROUGH STANDARD ENGINE



STANDARD "RANGE II" ENGINE

supercharged engine, Mark 12Y.H.A.X., and we reproduce in our line drawing a cross section of the engine.

A fully heat-treated aluminium alloy casting forms the crankcase, which provides mounting supports for the whole engine and has attached to its underface a strongly constructed sump, fabricated from aluminium alloy sheet. High-expansion austenitic steel studs fasten the separate cylinder blocks, which carry wet pre-finished cylinder liners to the crankcase. Heat-treated aluminium alloy is used for the unit cylinder head castings, which embody two exhaust and two inlet valves, each of the latter having a port. There are no cutaways in the liners and the valves, which are not masked, have screwed-in aluminium bronze seats. A copper ring located in the top flange of the cylinder liner forms the gas-tight joint and the heads are secured to the cylinder blocks by six high-expansion austenitic steel studs. Efficient cooling of the valve seats and the injector is effected by passing the cooling water downward around the injector and then spraying it out over the bottom deck of the cylinder head.

Aluminium alloy pistons are supplied and fitted with three compression and two oil control rings and can be removed through doors in the crankcase. Steel stampings of H section form the connecting-rods, the forked rod being connected by means of four high-tensile steel bolts to the big end block, which is chromium plated on its outer diameter to ensure minimum wear for the blade rod bearing track. The underslung crankshaft, which has solid pins and journals and a forged flange at the drive end, is of heat-treated alloy steel and is carried in forged aluminium alloy bearing caps. All the main and big end bearings are of shell pattern copper lead lined and steel backed, and lead plated to assist running-in.

The camshaft, which is in chill-cast Monochrome iron and has two cams per cylinder, is located centrally in the cylinder vee in a self-contained cam box. A heavy-duty duplex chain drives the camshaft from the engine crankshaft. The totally enclosed and well-lubricated camshaft operates the parallel motion valve gear through swinging hardened steel roller cam followers, tubular push rods, and pressure lubricated valve rockers made of aluminium alloy stampings. The block pattern fuel pumps are mounted immediately above the camshaft and driven from it. The firing order is such that the minimum length of piping is used to deliver fuel to the injector which is mounted centrally between the four valves.

Speed control is by a governor of hydraulic servo flyweight pattern, which is accentuated by the engine oil pressure and acts as a safety device should the lubricating oil supply fail. For marine purposes the governor controls are remote and interlocked with the gearbox controls to form a system for linking gearbox operation with engine speed.

All working parts of the engine are lubricated by means of a positive displacement gear pump driven from the free end of the crankshaft through a flexibly mounted gear train. At the same end of the engine are twin, flange-mounted, engine-driven centrifugal cooling water pumps driven through quill shafts.

Each twelve-cylinder engine is fitted with two exhaust-driven turbo pressure chargers, which are mounted on cast aluminium alloy brackets attached to the crankcase at the drive end of the engine. The air passes through large-diameter extruded aluminium alloy pipes, supported above the cylinder head covers, to intercoolers, one per cylinder bank, fitted at the top of the free end of the engine and supported by the gearcase. After passing through the intercoolers the air flows to the inlet manifold, which is supported beneath the exhaust manifolds. By this arrangement the supercharged engine is only slightly longer than the normally aspirated unit, and the weight of the additional fittings is evenly distributed on the mountings. The exhaust pipes, which are cast in austenitic iron, have expansion sections and are mounted outboard of the cylinders. Lagging of the pipes is by sprayed asbestos, and additional protection is afforded by an asbestos-lagged wire mesh guard, which covers the exhaust system and the inlet to the supercharger turbine.

For most of the Admiralty applications an extruded aluminium alloy bearer is attached to the underface of the crankcase with a resilient mounting interposed. The bearers support the salt water pump which is belt driven from the free end of the crankshaft and supplies cooling water for the air intercoolers and heat exchanger.

The National Physical Laboratory

ON Friday last, May 23rd, the National Physical Laboratory was once again thrown open to members from research associations, government departments, industrial firms, universities and other technical bodies interested in its work. These annual "open days" provide large numbers of visitors with an excellent opportunity of seeing the work in progress over the wide field covered by the laboratory, as well as to inspect that being carried out in the field, in which they are particularly interested. In each of the ten major divisions under which work is classified in the laboratories, interesting exhibits showing fundamental research and applied technology were arranged, and the people directly concerned with the work were generally available to answer questions and discuss particular problems. In the few hours for which the laboratories were open the visitors had little time to obtain more than a brief general glimpse of much of the work, and to touch briefly on more than a few of the activities in the divisions. In the notes which follow brief particulars are given of some of the work in progress in a few of the divisions of the laboratory.

Aerodynamics Division

In this division investigations are in progress on the characteristics of trailing edge-controls on aerofoils moving at high subsonic speeds. The formation and movement of shock waves on the surface of an aerofoil moving at high subsonic speeds may lead to rapid changes in the characteristics of control surfaces situated near the trailing edge. Thus, at high Mach number, the effect of a displacement of the control on the aerodynamic loads on the aerofoil may differ widely from that at low speeds, and in some cases may even be of opposite sense. Similarly, the hinge moment needed to serve the control may show large and erratic changes as the Mach number is altered.

These problems are of great importance in flight and the fundamental changes of flow pattern which lead to the changes of control characteristics are being investigated in a 20in by 8in tunnel at the laboratory. At present tests are in progress on a 10 per cent thick aerofoil fitted with a 25 per cent control surface. These tests are to be followed by experiments with thinner aerofoils. In them, to investigate the effects of the state of the boundary layer, provision is being made for fixing transition to turbulent flow close to the leading edge by allowing a minute quantity of air to flow into the boundary layer from a row of holes along the span.

Other work concerns the pitching moment derivatives on an oscillating delta wing. The delta and arrowhead plan forms of modern fighter aircraft are liable to give rise to undamped pitching oscillations, especially at high speeds, and such undamped oscillations make a machine unstable and difficult to control. For these investigations an arrowhead wing in the low turbulence tunnel is forced to oscillate in pitch by applying a reciprocating force through a spring, and the movements of the wing recorded photographically. Results obtained from these experiments at low speeds on oscillating wings are useful in estimating performance at high speeds as they provide data for checking at low speeds the various theories in use for predicting results for swept-back and delta-wings to find out which in theory is the most reliable.

Light Division

During the past few years this division has been engaged, as part of its work of development of improved techniques for the production of instruments and components, in the development of methods for producing replica diffraction gratings of high optical quality. These diffraction gratings are mirrors which bear on their surfaces a large number of equally spaced grooves, and they are used for the analysis of visible light and ultra-violet and infra-red radiation. Such gratings are in demand by astronomers, spectroscopists and chemists.

The production of diffraction gratings is a task of considerable technical difficulty because it involves the ruling of many thousands of grooves to the inch, each groove being positioned to an accuracy of the order of a micro-inch. Hitherto this operation has been performed by a ruling engine similar in principle to a planing or shaping machine but of much higher precision.

As a result of a suggestion by Sir Thomas Merton, the Light Division developed a new approach to the problem. Under the system now used the grating is first produced as an infinitely fine screw thread on a metal bar and then, through the medium of a plastic coating, transferred to an optically flat surface. In the sequence of operations one-half of the cylindrical bar is first threaded in a high precision lathe. The bar is then transferred to another lathe where the other half is screwed, using the original thread as a lead screw. In the second lathe the tool is fed by a pad of cork or similar material about an inch long, which grips the original thread. By this means of feeding the cutting tool—a diamond—any inequalities in the original thread are averaged out over a length of an inch and a nearly perfect thread pitch is obtained.

One of the many advantages of the new process, which appeals particularly to instrument manufacturers, is that each cylindrical ruling can be used for producing cheaply an unlimited number of identical gratings. We were informed that the new N.P.L. diffraction gratings are already finding a ready application in the field of infra-red spectroscopy, where they are replacing costly prisms of such materials as lithium fluoride and calcium fluoride in the work of exploring molecular structure.

Metallurgy Division

An interesting method of machining pieces of metal required for tensile test specimens without the use of normal turning methods and tools has been introduced by the Metallurgy Division. As a rule tensile test specimens can be machined in the normal way with safety because they are large enough for the thin surface layer strained by the machining operation to be discounted. But when a machine was acquired by the division for which the standard size of specimen was only $\frac{1}{8}$in diameter this layer could no longer be ignored. Although for soft materials ordinary machining could not be used, the specimens had to be shaped to have an accurately parallel gauge length and correctly curved ends. To overcome this problem the specimen is made the anode in a rather unusual electrolytic cell, and in this adaptation of the electrolytic polishing process specimens can be produced to correct dimensions with an unstrained but highly polished surface.

In the apparatus the specimen blank is rapidly rotated and at the same time reciprocated along its axis, at a constant rate to avoid "barrelling" of the specimen. During these movements a jet of suitable solution is played upon the blank and covers successively every point of the surface. A current passed between the blank as anode and a cathode arranged in the jet causes the blank to be dissolved away gradually and uniformly until the desired size is reached. This size is checked by means of a microscope mounted above the blank. If the current density is high enough and the

electrolyte suitable a truly electro-polished surface is produced which is free from irregularities under a high power microscope.

The arrangement of atoms in the structure of matter is revealed by the technique of X-ray diffraction. The method consists in general of irradiating a specimen with a narrow beam of X-rays and recording on a photographic plate the X-ray beams diffracted from the material, the intensity and directions of these beams depending amongst other things on the relative positions of the atoms one to another. In the past few years, however, various workers have replaced the photographic plate by a Geiger-Muller counter, which gives a direct measure of the X-ray intensity.

A precision Geiger-Muller spectrometer recently constructed in the laboratory is suitable for the application of the method to a wide variety of problems of both fundamental and technological importance. In particular its annular form of 14in internal diameter, makes the instrument capable of handling both large and small specimens and those which are to be examined under special conditions, necessitating ancillary equipment such as furnaces or mechanical strain devices. The precision of the spectrometer circle itself enables the counter to be positioned to an angular accuracy of plus or minus 17 seconds of arc.

The pulses in the instruments tube caused by the X-rays are amplified by appropriate electronic circuits and recorded on electronic and mechanical registers. In this way quantitative measurement of diffraction maxima may be achieved in a fraction of the time required to expose and process a photographic plate and make a photometric record of the blackening. In certain cases the relevant information may be provided by a measurement lasting a few seconds. To eliminate errors due to variation of the X-ray source a monitor tube is used to measure the beam incident on the specimen. When the monitor tube has received a predetermined number of counts it automatically stops the diffraction tube, the count of which thus corresponds to a fixed quantity of X-rays on the specimen. The overall accuracy attainable in intensity measurement is about 0·5 per cent.

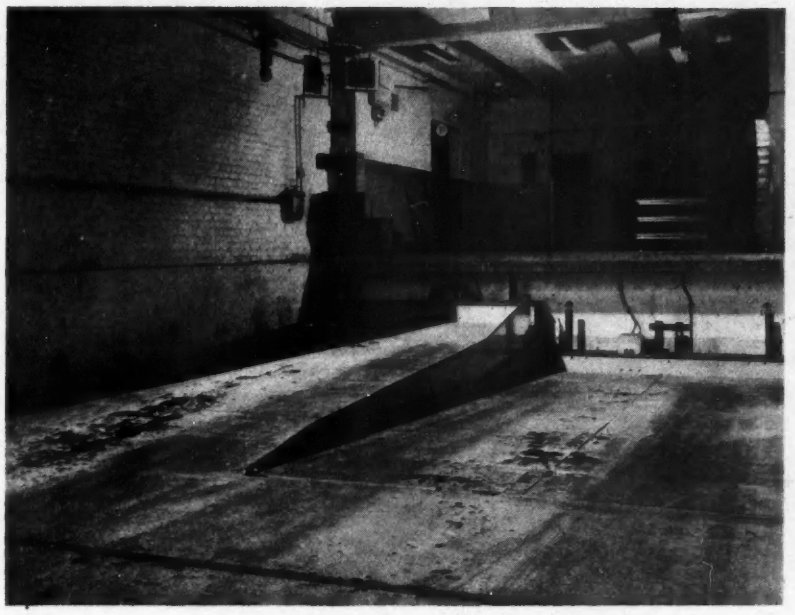
Ship Division

A readily adaptable and portable torsionmeter has been developed by the ship division for use on measured mile tracks with ships on which commercial instruments are not available or where a further check is required. The operating principle of this instrument is similar to that of a commercial unit in that the angular deflection of a length of shafting is measured by electrical inductance gauges. However, the deflection is transmitted from one end of the gauge length to the other by means of a small tube lying parallel to the shaft instead of a shell concentric with it. This arrangement has allowed a very considerable reduction in the size and weight of the instrument. The instrument is carried on hardened points bearing on the shaft and is clamped to it by chains. Screw adjustment of the chains and points enable the instrument to cover a range of shaft diameters from 14in to 22in. The angular movement is converted into a longitudinal movement of a small armature through the medium of a specially designed double helical spring. The displacement of the armature varies the inductance in a bridge circuit and the instrument is calibrated in terms of the rotation of a balancing potentiometer. An automatic revolution counter is built into the control box. Bench tests show an accuracy of the same order as that of standard instruments.

A mock-up was shown of a machine which is being developed for the manufacture of model screws.

In the present method of manufacturing model screws, measurement of the blade section must be made by reference to the pitch face, which may eventually be lost in the process of cutting. Unless considerable time and care are taken, cumulative errors can arise in this process. In order to obtain acceptable accuracy in the short time demanded by pressure of test work, it is desirable to find some method of cutting sections with reference to a fixed datum plane. The Division experimented with the possibility of cutting model blade sections directly from a flat enlarged drawing. Reasonably good results were obtained but it was evident that a considerable amount of time and money would be required in order to make a machine practicable for everyday use.

In order to obtain more immediate results a new scheme was initiated in which two stages are involved between the drawing and the screw. In the first stage thin steel templates are cut from an enlarged drawing through a pantagraph mechanism, a scale ratio of 5 : 1 being employed. The templates are then clamped round cylindrical formers in such a way that they give a correct skeleton replica of the face or back of the screw. These formers are mounted on a shaft carrying the screw and this shaft is rotated and advanced so that a follower at its end maintains contact with the template whilst an electrically driven point cutter traces the correct section on the model screw blank. At the present stage the "mock-up" screw cutting assembly is well advanced and the template cutting machine in hand. On the final version of the machine it is hoped to cut all four blades of a propeller in one operation.



Loading Dock with Two Levelling Units

A Vehicle-Loading Platform Levelling Device

To obviate the difficulties experienced at loading docks where road vehicles having different platform heights are loaded and unloaded, a new device known as the "Flush-decker" has been introduced by Strachan and Henshaw, Ltd., St. Philip's, Bristol, 2. This device, which is illustrated on this page, consists essentially of an adjustable pivoted ramp or section of roadway approaching the loading platform.

Through mechanism driven by an electric motor the end of the ramp nearest the loading platform can be raised or lowered by pressing the appropriate push button, until the floor of a road vehicle is flush with the floor of the platform. Goods in stillages or on pallets can then be carried on their trucks straight on or off a lorry. As the lorry body sinks lower or rises on its springs, with the increasing or decreasing of its load, the alignment of its floor with the platform of the dock can be maintained by means of the control push buttons of the ramp.

The ramp consists of a substantial mild steel framework covered by concrete slabs, and the back end is raised and lowered by a 10 h.p. motor through spur gearing. This mechanism is mounted on a framework pivoted from the ramp framework and drives two substantial nuts which are wound up and down two square thread screws, one at each side of the ramp, pivoted from brackets mounted on the floor of the shallow pit in which the unit is installed.

The motor is operated by contactor starter with control push buttons, and limit switches are provided to prevent the ramp being raised or lowered too far.

Apart from the shallow trench, about 28in deep, required to accommodate the ramp in its lowered position, the only other special site requirement is that the loading platform should overhang by about 2ft. 6in to accommodate the operating gear. The normal size of a "Flush-decker" unit is designed to accommodate and handle lorries up to about 15 tons load, although heavier lorries could be handled by suitable strengthening of the deck and operating gear.

Combustion of Coal.—With the intention of stimulating interest in the economy in the use of coal International Combustion, Ltd., has sponsored a film entitled "Combustion," which was exhibited in London last week. The film is divided broadly into three parts, which deal with the formation of coal, the development of combustion and pulverised firing. In the opening sequence animated diagrams show the formation of coal and its gradual adoption as fuel, together with an experiment which illustrates its four main constituents. The section shows the development of combustion from the early simple methods to the exact science which it has become to-day. Hand stoking was superseded by mechanical methods and with the increase in the size of steam generating plant in industry with a capacity up to 300,000 lb of steam per hour travelling grate stokers came into use. In the final sequence the firing of larger boilers is dealt with and shows the development of pulverised fuel firing technique, by which the efficient combustion of small coal is achieved. The coal is ground to a fine powder and mixed with air before being blown through distribution piping to burners, the latest development of which, the tilting corner burner, is demonstrated. The 16mm film, which has a running time of twenty-five minutes, can be obtained on free loan to responsible bodies from International Combustion, Ltd., 19, Woburn Place, London, W.C.1.

Metallurgical Topics

High-Tensile Weldable Structural Steels

In the course of a comprehensive study of the weldability of low-alloy steels, J. G. Ball and C. L. M. Cottrell[1] devoted considerable attention to the mechanical properties of the steels in their original hot-rolled or normalised condition. The steels investigated contained 0·13 to 0·17 per cent carbon and 0·21 to 0·265 per cent molybdenum, with varying amounts of manganese (up to 1·7 per cent), nickel (up to 1·6 per cent) and chromium (up to 1 per cent). Four samples also contained 1 per cent of copper.

A characteristic property revealed by all these Mn-Ni-Cr-Mo steels in the normalised condition was a slow departure from proportionality so that a permanent set of 0·02 per cent occurred in many cases at 10 to 15 tons per square inch below the 0·3 per cent proof stress. This applied not only to the steels in the higher range of alloy content within the above limits, but also to the steels of lower alloy content, suitable for welding, which had no very pronounced air-hardening characteristics as measured by tensile strength or hardness. All these weldable low-alloy steels were shown to be greatly improved by tempering the normalised steel at temperatures between 200 deg. and 600 deg. Cent. The highest value of the 0·3 per cent proof stress was obtained by tempering at 300 deg. Cent. With higher tempering temperatures this value was lowered slightly, but the proof stress based on 0·1 per cent permanent extension was raised until the two almost coincided after tempering at 600 deg. Cent. and a more definite yield point was obtained. At the same time, the elongation and reduction of area were improved. Results shown in Fig. 1 were obtained with a ½in

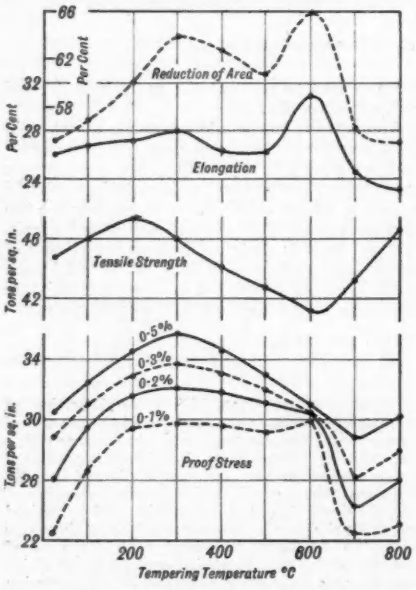


Fig. 1—*Effect of Tempering (Followed by Cooling in Air) on the Mechanical Properties of ½in Normalised Plate of Steel Containing C 0·16, Mn 1·15, Ni 1·00, Cr 0·25, and Mo 0·22 per cent (Ball and Cottrell)*

normalised plate containing carbon 0·16, manganese 1·15, nickel 1·00, chromium 0·25 and molybdenum 0·22 per cent. The effect was demonstrated by photomicrographs to be due to the occurrence of hard martensitic particles in the structure of the normalised steel, and their subsequent conversion into a tough sorbitic structure on tempering. To obtain the best combination of properties, both in the weld and in the normalised or hot-rolled plate, it is evidently desirable to minimise the formation of the harder low-ductility products of austenite transformation and utilise as far as possible the effect of small grain size and solid solution hardening of the ferrite. The strength so obtained is, however, often inadequate and the presence of a limited amount of the low-ductility product in the structure has to be accepted, with the consequence that tempering is necessary to give the best properties, though for many purposes tempering may be dispensed with.

Steel for Bridges

Ball and Cottrell were interested primarily in weldability and only incidentally in the mechanical properties of the parent material. Another aspect of the same problem is discussed in a report recently issued by the Ministry of Supply,[2] which describes an investigation into the relationship between stress and strain in a high-tensile weldable structural steel used in the construction of a prefabricated transportable bridge. The steels under investigation were low-carbon, manganese-molybdenum steels containing carbon about 0·17 per cent with manganese 1·26 to 1·48, molybdenum 0·23 to 0·31, nickel 0·33 to 0·43, chromium 0·04 to 0·14, copper 0·12 to 0·35, and vanadium nil to 0·05 per cent. They gave a minimum 0·3 per cent proof stress of 28 tons per square inch for thicknesses of less than ½in in the as-rolled condition.

Previously a straight carbon-manganese steel had been used for this type of work with a 0·3 per cent proof stress of 23 tons per square inch, so that, at first sight, the new steel promised a weight saving of approximately 20 per cent. Such a saving would be invaluable in this kind of structure where the economies of transport and erection are so dependent on the weight of individual units. There was, however, a marked difference in the stress-strain curves of these two steels for values up to the proof stress. Whereas the carbon-manganese steel gave a limit of proportionality reasonably close to the yield point, the manganese-molybdenum steel was sometimes found to have a limit of proportionality of only about 12 tons per square inch, or less than half the 0·3 per cent proof stress. For the application in view, such a low limit of proportionality was prohibitive because the individual components might distort sufficiently to endanger the interchangeability of parts and, therefore, to defeat the whole purpose of the prefabrication. Even under working loads the permanent set given to members was of the same order as the manufacturers' tolerances on ruling dimensions, while a proving load, which is applied as an overload to each part in the course of manufacture would cause distortions sufficient to prevent assembly taking place.

Tests confirmed that the non-elastic behaviour of this steel was characteristic of complete structural members, as well as of tensile test pieces. To take full advantage of the capabilities of the steel, an investigation was made to ascertain whether there was any commercially practicable means of extending the linear part of the stress-strain curve. In this connection a new proof stress for 0·02 per cent permanent extension was introduced. This represented the limit of distortion allowable for the structure.

As in ½in plate of other high-tensile structural steels of similar composition, the most noticeable result of the tests in both the hot-rolled and the normalised conditions was the very low limit of proportionality, a characteristic which was eliminated by tempering at a sufficiently high temperature below the critical range. This effect is demonstrated in the report by a series of tensile tests, and the accompanying changes in microstructure are illustrated by numerous photomicrographs. Microscopical examination of the steels with low limits of proportionality revealed, usually in the pearlitic regions, very small dispersed particles of an austenite decomposition product, probably an

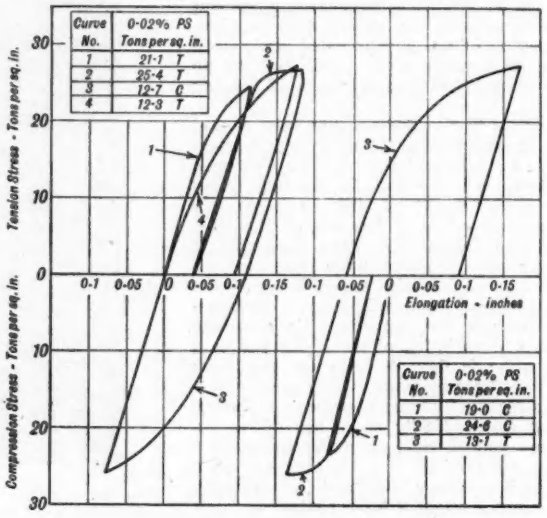


Fig. 2—*Behaviour of Typical Structural Members Under Alternate Tension and Compression Loading. Specimens 6in by 3in Channels, Gauge Length 36in, in Hot-Rolled Steel Containing C 0·17, Mn 1·27, Ni 0·43, Cr 0·07, Mo 0·25, and Cu 0·29 (Smith and Whitman)*

irresolvable martensite, which on tempering was converted into a sorbitic structure of coalesced carbide. X-ray diffraction patterns showed features in good correlation with the microstructure. The peculiarities of the stress-strain curve and the formation of martensite appeared to be closely related to the molybdenum content of the steel. A manganese-molybdenum steel with 0·13 per cent molybdenum did not show these characteristics, but its yield strength was inadequate. With increase in the amount of molybdenum present, delay in the austenite-pearlite transformation causes the retention of a certain amount of austenite which transforms at a lower temperature. There was a considerable increase in this "air-hardening" effect when the molybdenum reached 0·3 per cent, but the behaviour of the steel with just over 0·2 per cent was variable, and certain avoidance of low limits of proportionality in hot-rolled steel of this molybdenum content could not be ensured by further control of manufacturing procedure.

A single application of load up to a point on the non-linear part of the stress-strain curve produced a much more nearly linear relationship on subsequent loading, and, in some circumstances, prestressing might be an economical method of raising the 0·02 per cent proof stress. For the purpose in view, however, both tension and compression tests were necessary, as the bridge members were subjected to compression and tension loads. The stress giving 0·02 per cent permanent compression was no higher than the corresponding tensile stress. Two specimens consisting of typical structural members were subjected to alternate tension and compression loading, as shown in

Fig. 2. These results illustrate the stress-strain relationships with different combinations of tension and compression loading, and indicate that as the normal hysteresis loop is applicable to this early departure from proportionality, no overall advantage is to be gained by prestressing.

The general conclusions derived from the work described in the report were that steel containing carbon 0·18, manganese 1·35 and molybdenum 0·25 per cent shows, in the hot-rolled or normalised condition, a low limit of proportionality in relation to yield stress, and this adversely affects strength and interchangeability of parts of prefabricated transportable bridges. A 0·02 per cent proof stress of 20·5 tons per square inch was generally (but not with complete certainty) obtainable with this steel in the hot-rolled condition, but a higher value could not consistently be obtained without tempering. Tempering at 600 deg. Cent. raised the value of the 0·02 per cent proof stress very considerably, and greatly improved the limit of proportionality and the notched-bar impact figure.

[1] J. G. Ball and C. L. M. Cottrell, "The Weldability and Mechanical Properties of a Series of Low-Alloy Steels," *Journal of the Iron and Steel Institute*, December, 1951, page 321.

[2] D. W. Smith and J. G. Whitman in collaboration with C. L. M. Cottrell, "Stress-Strain Relationship of a High-Tensile Weldable Structural Steel," *Ministry of Supply, Directorate of Weapons Research (Defence)*, W.R.D. 11/51, October, 1951. Crown copyright reserved. Published by permission of the Chief Scientist, Ministry of Supply, and of the Controller of H.M. Stationery Office.

Cemented Carbides

Among the more important products of the electrothermal processes developed during the past half-century are the metallic carbides. Tungsten carbide has long been a well-established commercial product, but the number of carbides coming into use continues to grow, and there is ample evidence of the good properties of many of these sintered products. Foremost among them is titanium carbide, which, in a matrix of nickel or cobalt, has been used for gas turbine blades, as well as finding numerous other applications on account of its high resistance to wear and to corrosion.

Mention was made of this class of material at the Symposium on High-Temperature Steels and Alloys for Gas Turbines, held in London last year, when it was stated that important developments in Great Britain and in the U.S.A. had shown the practicability of obtaining good high-temperature properties in materials of this type. Alloys containing 50 per cent or more of titanium carbide had been prepared by powder-metallurgy methods, and some of these had shown good creep and fatigue properties at high temperature. An attractive feature is the low density of the compacts—lower than that of any alloy used at present for turbine blades—the density of titanium carbide itself being only 4·25. There is also the possibility of the blades, as sintered, being produced almost in their final form. On the other hand, special precautions are needed in design to counteract the low ductility of the sintered product.

On the occasion referred to, Mr. S. T. Harrison, of Armstrong Siddeley Motors, Ltd., described the creep properties of 50 : 50 titanium carbide-nickel compacts at 750 deg. Cent. as satisfactory, and the fatigue curves obtained at 700 deg. to 800 deg. Cent. as uniformly good. Resistance to scaling was improved by additions of chromium carbide. Carbides bonded with cobalt had better creep properties than those in which nickel was used as a binder, but they were more difficult to grind. The outstanding problem in the utilisation of these materials was the avoidance, or reduction to within safe limits, of stress concentrations at the root of the blade.

A group of cemented carbides, based on titanium and produced by Kennametal, Inc., is known as Kentanium (the name Kennametal covering the tungsten carbide compositions). Some types contain niobium and tantalum carbides in addition. Nickel is used for bonding in preference to cobalt. A description of Kentanium products and of some of their uses is given by J. C. Redmond and J. W. Graham.[1] They have a hardness of 83–93 Rockwell A, equivalent to 1000–1400 diamond pyramid hardness, and a density of 5·5 to 6·5. Their modulus of elasticity is about 55×10^6 lb per square inch. Their tensile strength (about 40 tons per square inch at room temperature) falls off at high temperatures, being about 25

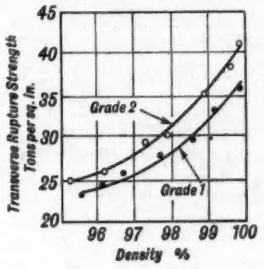
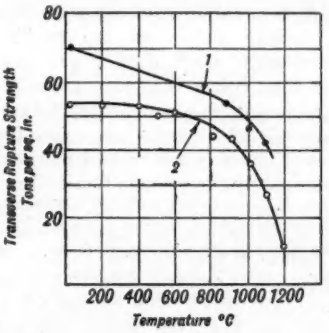


Fig. 1—*Influence of Density on Transverse Rupture Strength of Sintered Binder-Free Titanium Carbide (Glaser and Ivanick)*

tons per square inch at 800 deg. Cent., about 16 at 1000 deg., 5·5 at 1200 deg., and 1·3 tons per square inch at 1300 deg. Cent. Their compression strength will, except possibly at very high temperatures, be much higher, being about 240 tons per square inch at room temperature. In stress-rupture curves they have a distinct advantage over Inconel X at 870 deg. Cent. Resistance to oxidation at temperatures up to 1000 deg. Cent. is good and may, within limits, be adjusted to the requirements of their application.

F. W. Glaser and W. Ivanick,[2] associated with the American Electro Metal Corporation, have made use of a pressure sintering method consisting of sintering at 3000 deg. Cent. under a constant pressure of 1·3 tons per square inch to produce non-porous binder-free titanium carbide specimens having densities well over 99 per cent of the true density of titanium carbide. The effect of reduction of pore space on the transverse rupture strength was very



Curve 1: 80 per cent titanium carbide with 20 per cent cobalt.
Curve 2: Binder-free titanium carbide (also titanium carbide with 10 per cent binder).

Fig. 2—*Effect of Temperature on the Transverse Rupture Strength of Cemented and Binder-Free Titanium Carbide (Glaser and Ivanick)*

great, as shown by the comparative tests recorded by the curves in Fig. 1. The upper curve refers to the grade 2 carbide and the lower curve to the less pure grade 1. The percentage compositions of the two grades were as follows :—

	Grade 1	Grade 2
Titanium	78·5	79·1
Combined carbon	18·4	19·3
Graphitic carbon	1·3	0·6

The chief impurity was tungsten. Additions of 5 or 10 per cent of binder (nickel or cobalt or 50 : 50 nickel-cobalt) had little, if any, effect on transverse rupture strength. A higher transverse rupture strength was obtained with approximately 20 per cent of binder additions, and this value was a maximum, not exceeded by adding more binder. It was also observed that the transverse rupture strength was substantially the same whichever binder had been used, whether nickel, cobalt or nickel-cobalt. The curve of transverse rupture strength dips sharply at over 1000 deg. Cent. (Fig. 2). This is generally attributed to the gradual softening of the metallic bond, but the binder-free carbide behaves similarly (curve 2, Fig. 2), and the properties of the carbide itself must evidently be taken into account in the explanation. The curve for the binder-free carbide is also representative of results given by cemented titanium carbide with 10 per cent of binder. The transverse rupture strength of pressure-sintered titanium carbide is on an approximate equality throughout with that of cemented carbide containing up to 10 per cent of nickel or cobalt, but it seems probable that the brittleness of binder-free material will militate against its use. To obtain uniformity of results the manufacturing process needs control in all its details. The strength of the cemented product derives from the intrinsic hardness and strength of the carbide, together with the restriction which the carbide particles impose on flow of the metallic bond. The actual properties of titanium carbide compacts are, therefore, related to composition, particle size of powder, sintering times and temperatures.

Research on cemented carbides and borides has everywhere been accelerated on account of the possible use of such materials in connection with gas turbine components, rocket nozzles and other high-temperature applications, and new developments are frequently announced. One of these, described by J. J. Gillespie and I. L. Wallace,[3] of the Carboloy Department of the General Electric Company, is the production of cemented chromium carbide containing 2 per cent of tungsten carbide and 15 per cent of nickel, and having a hardness of 88 Rockwell A (about 1200 D.P.H.), a high resistance to oxidation and a low density compared with tungsten carbide. Work on the borides is not so advanced. A study of borides in metal-carbon-boron systems has been made by F. W. Glaser,[4] who has already produced a binder-free zirconium boride by pressure sintering, and there will probably be a wide field of application for the cemented borides when their properties have been more fully explored.

[1] *Metal Progress*, April, 1952, Vol. 61, page 67.
[2] *Journal of Metals*, April, 1952, page 387.
[3] *Steel*, April 21, 1952, page 84.
[4] *Journal of Metals*, April, 1952, page 391.

Welding of Copper

The electric welding of copper and its alloys is a modern development, whilst brazing as a means of joining metals is a method of great antiquity. The whole range of processes employed in joining copper and its alloys is reviewed in the latest publication of the Copper Development Association.* The quality of a joint will depend on the skill of the operator, and the book is not intended to lessen the need for workshop instruction or practice. It does, however, fully describe the underlying principles of the main welding methods. The difficulties likely to be encountered are clearly stated and their solution indicated. The book, which is well produced and illustrated, should be of great value to those engaged in the welding industry, and will interest all potential users of copper or copper-alloy articles or components which may be frabricated by welding, brazing or soldering.

Conference on Hot Dip Galvanising.—The Zinc Development Association is arranging an International Conference on Hot Dip Galvanising, which is to be held at Düsseldorf from June 30th to July 4th. It is expected that about 150 galvanising experts from European countries and from the U.S.A. will participate. The papers to be discussed deal with fundamental matters, such as coating structures and electrochemical behaviour and also with practical questions, such as bath heating and operation and the galvanising of castings.

* "The Welding, Brazing and Soldering of Copper and its Alloys," C.D.A. Publication No. 47, Copper Development Association, Kendals Hall, Radlett, Herts.

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GAS TURBINE LOCOMOTIVES

RATHER more than two years ago considerable interest was aroused by the introduction of the first gas turbine electric locomotive on the Western Region of British Railways. It was perhaps only natural that so novel a form of motive power should fall a victim to various teething troubles, and the nature of the equipment and unfamiliarity of enginemen with it, tended to make these troubles seem more serious than they actually were, since the locomotive had to be removed from its train on a number of occasions. But in favourable conditions the capacity of the locomotive as a motive power unit was made evident on a number of fast runs during the summer of 1950, and we published some running details in our issue of July 13, 1951. In the late autumn of that year a series of road trials with the dynamometer car was carried out by the testing staff at Swindon. The results have now been made public by the Railway Executive and the report was printed in full in our issue of May 16th. The tests were carried out in such a way as to render them closely comparable with the performance of steam locomotives of roughly equal tractive power, and if reference is made to our issue of April 20, 1951, wherein we published some characteristic curves relating to the Western Region "Castle" class locomotives, some striking differences will be noted in those of the gas turbine, particularly the curves in which fuel per drawbar horsepower hour and fuel per ton mile are plotted against speed. Whereas the efficiency of the "Castle" class engine has begun to decrease by the time a steam rate of 20,000 lb per hour is attained, the maximum operating efficiency of the gas turbine coincides with high power output. Herein appears to lie an inherent disadvantage of the gas turbine locomotive on the class of railway duty in which it was tested.

The trials were conducted on two regular express passenger trains on the West of England service between Paddington and Plymouth, 225·2 miles. The route includes many steep and awkward gradients and the trains on which the tests were made include a number of intermediate stops. Of the total distance in each direction less than 190 miles was covered with the locomotive under power and the average drawbar pull was less than 750 on three out of the four runs made. This low average demand, compared with the large demand made for short periods on certain heavy stretches of the road, is a characteristic of British passenger train operating that was commented upon in the report on the interchange trials of 1948; so far as the gas turbine locomotive was concerned it meant that operation did not often reach the ranges of maximum efficiency. At the same time the two trains concerned are in every way typical of present-day time-table demands, and the 3.30 p.m. down from Paddington with its opening run of 142¾ miles non-stop to Taunton at an average speed of 58 m.p.h., is above rather than below the general standard in this country. The one figure in the table of tests results likely to raise more interest than any other is the overall efficiency, as represented by the average fuel consumption per drawbar horsepower hour. This showed fairly consistent results from the four runs, with values of 2·05 lb, 1·93 lb, 2·17 lb and 2·12 lb. It is perhaps significant that the journey on which the consumption was lowest was that on which the average drawbar horsepower was 831, against the general level of 720 to 740 on the other three runs.

The overall fuel consumption per drawbar horsepower hour is one important criterion by which the locomotive itself must be judged, since economy in fuel was one of the major objects of the experiment of purchasing such a machine. The gas turbine, using fuel with a calorific value of some 18,500 B.Th.U.s per lb, used, on an average, 2·05 lb per d.h.p. hour, whereas the Western Region four-cylinder 4–6–0 express locomotives of the "King" and "Castle" classes, using Welsh coal with a calorific value of 14,500 to 15,000 B.Th.U.s per lb, show an average consumption in similar work of 2·8 lb to 3·2 lb per d.h.p. hour. This suggests an improvement of some 12 to 13 per cent in favour of the gas turbine, despite the unfavourable conditions of a duty with such fluctuating demands for power. But while it is probably true to assume that the overall efficiency of the gas turbine locomotive would appear more favourable on a long through run with a high constant demand for power, the same also is true for the Swindon-designed steam locomotives. The coal consumption of a "Castle" class engine, as measured on the stationary testing plant, is no more than 2·7 lb per d.h.p. hour when running at 55 m.p.h. with a steam rate of 15,000 lb per hour. All the same, we feel that the gain in efficiency demonstrated by the gas turbine is less than was generally expected, and it will be most interesting to learn, in due course, if the considerably larger British-built gas turbine locomotive shows an appreciable improvement. There can be no doubt that this latter machine is, by a considerable margin, the most powerful express passenger locomotive that has yet appeared on British Railways, and difficulty may well be experienced in finding duties worthy of its capacity. But this remarkable project is being conducted jointly by British Railways and Metropolitan-Vickers, and the results may be as advantageous to our export trade in locomotives as to the motive power position on the home railways. In the meantime the test results from the Brown-Boveri locomotive will be closely studied and engineers far and wide will be grateful to the Railway Executive for making public so comprehensive a report.

A FULL-SCALE STRUCTURAL TEST

IN our last issue details were given of the results of the tests which were carried out recently on the prestressed concrete footbridge at the South Bank exhibition site in London. It is not often that the opportunity arises for the full-scale testing, including a test to destruction, of a structure of any magnitude, and the tests have therefore been followed with considerable interest by many engineers. This interest was enhanced by the use of prestressed concrete, the material which has had so much discussion and publicity devoted to it, and which is now gaining a foothold in structural practice. The use of that material is by no means free from controversy at the present stage of its development, and in the interpretation of the results of these tests, some differences of opinion have arisen. The final conclusions which can be drawn from the tests will take time to assess. It is intended to refer to them, and also to similar results for the testing of the prestressed concrete restaurant roof at the South Bank site, to be carried out shortly, at the congress of the International Association for Bridge and Structural Engineers in September, so that they may be fully discussed and evaluated.

In considering the results it should be borne in mind that the structure was a temporary one and that it was proportioned primarily to follow the æsthetic requirements of the architect's design. But it was also designed to give as great an economy as possible, within those requirements, taking into account its limited life. The design load was 100 lb per square foot between handrails, which was considered a safe maximum. An accidental overload was not considered probable; the bridge was

approached by stairs at each end, and was accessible only to pedestrians. The load factor at the collapse was about 2½, considering the live load alone, and about 1½ taking into account both the live load and the dead load of the structure's own weight. For the latter case a figure of 2 is generally taken as satisfactory for a permanent structure of steel or reinforced concrete. The properties of prestressed concrete indicate, however, that satisfactory working conditions under working loads can be obtained with a lower figure, and with experience a lower ultimate factor of safety may in time be considered satisfactory for this material. In view of the temporary nature of the footbridge, and the economy called for in its construction, its strength appeared to be adequate. There remains the fact, however, that a slightly higher ultimate load was expected than that which the bridge actually sustained. Several reasons may be put forward in explanation. The structure failed by forming three plastic hinges, one at the base of column 36, one at the centre of the span, and one at the top of column 37. The usual method of design calculates working stresses from working loads, but to estimate failing loads is more difficult, and there is no generally accepted method. The concrete appeared to behave satisfactorily and to attain the desired strength; and the behaviour of the anchorages also seemed satisfactory. However, the cables were not grouted solid with the surrounding concrete, thus tending to reduce the continuity moment at the columns and increase the moment at mid-span, due to slip between the cables and the concrete round them, in the region of high shearing force above the column. Another factor which, incidentally, was noticed at the time the bridge was built was the high coefficient of friction of the cables against the surrounding concrete, when they were tensioned. Thus the stress in the cables at a point midway between the anchorages was probably less than the estimated value. This factor, it is thought, may have accounted for the appearance of cracks at the load of 35 tons (that is, at the design load of 100 lb per square foot), but probably had little influence on the ultimate load. The various factors necessary for a good structure in addition to its ultimate load-bearing capacity, such as stiffness and recovery from overload, were considered to be adequate from the test results.

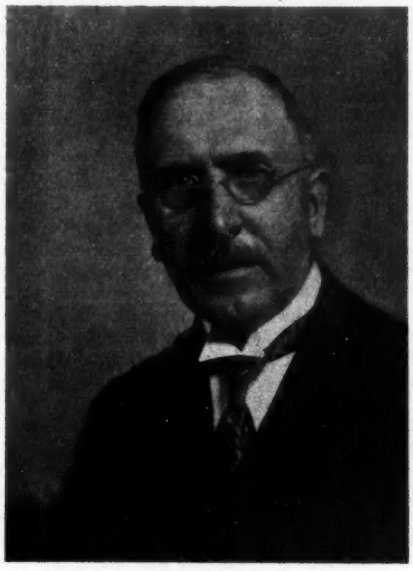
Practical experience in the construction of prestressed concrete structures is still limited. A background of years of practice doubtless has influence on the quality of a finished structure, so that the tests were of considerable value because of the comparative novelty of prestressed concrete and also because no tests were envisaged at the time the bridge was built. It therefore represents an average structure, receiving, probably, an average amount of care and attention in building, and the results may be interpreted accordingly, bearing in mind that it was to have a very short life.

LONDON TRANSPORT GARAGE.—A new bus garage has been put into service by London Transport at Gordon Road, Norbiton, near Kingston-on-Thames. The parking area, providing accommodation for seventy vehicles, is a steel-framed building with four pits for inspection and running repair work. Separate folding doors on two sides of the building allow for one-way operation of the vehicles.

Obituary

STANLEY SMITH COOK, F.R.S.

IT is with regret that we record the death of Mr. Stanley Smith Cook, which occurred at his home in Newcastle upon Tyne on May 21st at the age of seventy-seven, after a short illness. Mr. Cook, who was a director of Parsons Marine Steam Turbine Company, Ltd., was born in 1875, and was educated at King's School, Canterbury, from where he went to St. John's College, Cambridge University. He graduated in 1896 as Seventh Wrangler in the Mathematical Tripos, and in the following year obtained first-class honours in the Mechanical Sciences Tripos. After spending a short time as a tutor under Professor Ewing at the Engineering Laboratory, Cambridge, Mr. Cook joined the firm



S. S. COOK, F.R.S.

of C. A. Parsons and Co., Ltd., to obtain practical training and experience, and carried out experimental work on electrical generating plant. In 1903, he went to Parsons Marine Steam Turbine Company, Ltd., where he was associated with Sir Charles Parsons in research work connected with the development of the marine steam turbine, mechanical gearing and propellers. Mr. Cook, who became technical manager of the company in 1910, was appointed a director twenty years later, and retained his seat on the board after his retirement in 1948 until his death. Mr. Cook was elected a Fellow of the Royal Society in 1928, and was elected a Fellow of the North-East Coast Institution of Engineers and Shipbuilders in 1933; he was also a member of the Institution of Naval Architects, and of the Institute of Marine Engineers. In addition, he was a member of the various technical committees of Pametrada, and for some years represented the North-East Coast Institution of Engineers and Shipbuilders on the research board of B.S.R.A. Many papers have been written by Mr. Cook, in collaboration with Sir Charles Parsons and Mr. R. J. Walker, on steam turbines, mechanical gearing and propellers. He was awarded the Denny Gold Medal by the Institute of Marine Engineers in 1938, in which year he delivered the Parsons Memorial Lecture. Ten years later, in the year of his retirement, he gave the Andrew Laing Lecture.

Literature

Water Treatment for Industrial and Other Uses. By ESKELL NORDELL. London: Chapman and Hall, 37, Essex Street, W.C.2. Price 80s.

THIS publication should prove an interesting reference book with a wide field of interest for those who use water as part of their processes, or for engineers primarily interested in steam generation. By referring to the extensive Table No. 55 it would appear that there are few industries to be exempted. The author has in one volume combined a complete review and brought almost up to date the development in the technique of water treatment that has taken place in the last decade. With almost universal reorganisation of our industries the engineer and chemist are becoming more and more conscious of the fact that water as provided by public authorities to the recognised standards of purity for human consumption is rarely suitable, without considerable conditioning, for use in industry.

Mr. Nordell, being primarily a chemist, has largely reviewed the treatment of water from a chemist's point of view without, however, becoming too involved in chemical data for the average engineer to appreciate the book. The ground covered by the first four chapters has already been dealt with by eminent authorities in this country and their findings are probably more useful to British engineers, since they are based on water supplies which are found in this country, and which differ in some aspects from the examples given in this book. It is appreciated, however, that the author has had to review the chemical aspects of water in order that the reader might obtain a fuller understanding of the processes which are described in the later chapters. Much useful data has been given in these chapters, which will be appreciated by the student and those who are coming for the first time against the problem of conditioning their water supplies.

The chapter dealing with water requirements is of general interest, without adding any subject matter which is not already well known. The next chapters, covering boiler feed water, cooling water, aeration and deaeration, are interesting reviews of various phases of water treatment, and beyond indicating to the engineer and chemist the methods which are available, it has generally been left to the specialists in this class of work to design the most economical system for dealing with each of these phases. The chapter on chemical feeders and the following chapter dealing with sedimentation, coagulation, settling and filtration are rather disappointing, mainly due to the fact that the author has limited his review almost entirely to equipment manufactured by one important corporation. It would have greatly improved the value of these chapters if it had been possible to have stated the various applications to which one type of chemical gear is more suitable than another. Most engineers who have to handle water conditioning plant have long appreciated that the results obtained from the correctly designed plant are completely dependent upon the accuracy of the operation of the chemical feeding equipment, and in bringing up to date the developments in water treatment, it is regretted that this long-felt want for a review of chemical feeding apparatus has not been in any way met. In fact, it is felt that some of the types illustrated cannot be considered at all helpful to those who are faced with the problem of water conditioning.

Regarding the portion on filtration, there is, of course, the usual substantial gap between British practice and the practice of

our American friends, which is brought out again in these chapters. It would also appear from the illustrations that the details given in this chapter are not nearly so advanced in their design as those in the other chapters of the book. Chapters on iron and manganese removal and softening by either zeolite or lime/soda processes and the silica removal chapters have obviously been the author's main work, and in these chapters there is to be found one of the most complete reviews of modern plant design. One does, however, feel again that the book would have been considerably more interesting if some details of the instrumentation of these plants had been given, for although they are referred to from time to time, little or no description of this part of the work has been given.

The tables in the appendix will be found useful to students and also to those not used to the conversions which are necessary in such work.

In conclusion, one does appreciate the development that has taken place in this field of research work in the past few years and the large part the author's company has played in this development; but, as stated in his preface, the book is largely based on information from this one company and this in itself has made the book in some ways a catalogue of that company's products and limits the technical value considerably. Except for this criticism the book will certainly remain for some time a reference book of modern practice in water processing.

Deep Diving and Submarine Operations. By ROBERT H. DAVIS. London: The Saint Catherine Press, Ltd., 39, Parker Street, W.C.2. Price 35s.

IN 1935, when the fourth edition of Sir Robert Davis's manual for deep-sea divers was published, the safe maximum diving depth in a flexible dress was 300ft. The war and preparations for war put an end for the time being to the investigation of the problem of breathing under very high pressure, and it was not until 1946 that further experiments were begun. These experiments are described in the new edition. They took place in Loch Fyne from the specially designed deep diving vessel H.M.S. "Reclaim" and culminated in a successful descent by a naval diver to 540ft—a depth never before achieved by a flexible-suited diver. The author of "Deep Diving and Submarine Operations" is the managing director of Siebe, Gorman and Co., Ltd. He has succeeded to a remarkable degree in arousing the keen interest of the general reader in a technical subject of which most people have little or no knowledge.

The fifth and latest edition of his work, however, has also a universal appeal. It covers the war years, when there was an urgent demand for divers of a different kind—for divers who would be independent of air pipes, shot ropes and all the other paraphernalia associated with normal diving operations. They were required to operate "the human torpedo"; to walk out of a midget submarine on to the sea bed to fix explosive charges on to the hull of an enemy ship at anchor; to operate as "frogmen"; and to handle and render safe the magnetic mines laid off our coasts and harbours. The story of the many months of patient trials and experiments required before the demand could be met and of the subsequent exploits of these men, as related in this book, makes fascinating reading.

Success was finally achieved by the improvement and application to the diving dress of a self-contained breathing apparatus which was designed over seventy years ago by an Englishman, the late H. A. Fleuss, in collaboration with Siebe, Gorman and Co., Ltd. Its use until then had been confined mainly to work in poisonous atmospheres, though for a few years before the war it was also being used as the standard equipment for personnel escaping from sunken submarines. An essential part of the apparatus was the CO_2 absorbent to eliminate the poisonous carbon dioxide exhaled with the breath. The breathing medium normally used was pure oxygen, as this gas is consumed in the body tissues and leaves no tell-tale bubbles to warn the enemy. Breathing pure oxygen at a depth below about 33ft is apt to cause convulsions and "blackouts," but the "human torpedo" and midget submarine divers seldom remained below this depth for any length of time and suffered no ill effects.

There are other chapters, such as "Divers' Yarns and Adventures" and "Diving for Treasure," for those who want stories of adventure and thrills. But the main portion of this informative and instructive work is concerned with the problems of deep-sea diving, and the author is to be congratulated on the simplicity and clarity of his explanation of the scientific and physiological facts which it is necessary for the reader to understand. One of the major problems of the deep-sea diver is the nitrogen content of the air supplied to him, which dissolves in the blood in quantity proportional to the pressure. This has to be got rid of gradually in accordance with predetermined decompression tables before he can return to a normal pressure on the surface. Failure to do so means "bends" or diver's paralysis. Fortunately, however, it is no longer necessary for a diver, after remaining half an hour on the bottom at 200ft, to spend a whole hour coming up his shot rope in stages. Brief stops have to be made below 60ft, but by far the longest stage of decompression takes place above that depth, and this is now done in comparative comfort. The Davis submerged decompression chamber—acting as a diving bell—with an attendant in it, is lowered to a depth of 60ft, filled with air charged to the pressure at that depth. The attendant then opens the hatch, the diver enters the chamber, has his helmet and paraphernalia removed, the hatch is closed, and decompression is started in air instead of water. Meanwhile the chamber is hoisted on board the surface vessel, the diver is transferred to a larger and more comfortable decompression chamber and the original chamber is then lowered for another diver to ascend.

Narcosis, or nitrogen intoxication, is another trouble Its effects are extraordinary, and the author relates how a diver, sent down to report the position of a submarine and the damage, was heard on the telephone singing hilariously. At medium depths it is dealt with by reducing the nitrogen content and increasing the oxygen content of the air supplied to the diver, but this remedy is ineffective for very deep dives. At depths below 300ft a mixture of oxygen-helium is supplied. Helium is very scarce, practically the only source of supply being the United States, but it effectively prevents narcosis. It does not, however, remove the necessity for the lengthy decompression process.

In the chapter on methods of escaping from submarines, further reasons are given for the desirability of fitting two-men escape chambers in those submarines in which, for constructional reasons, they have not yet been installed. The alternative method of escape is to flood the compartment through a sea inlet until the air is compressed to a pressure equal to that of the depth. The personnel then put on their Davis escape apparatus and dip down one by one under the twill trunk, which has been let down from the compartment hatch. The first man then opens the hatch and each floats to the surface. It will be remembered that when the "Affray" was sunk, Government spokesmen referred to the possibility of the vessel being found lying on the bottom with a heavy list and emphasised that the list would be increased by flooding a compartment to escape. There was also the added difficulty of the men floundering about with no floor boards to walk on. Sir Robert points out in this book that there would also be a considerable amount of CO_2 in the compartment, which, if breathed under pressure, would soon poison the personnel. None of these considerations arises in an escape chamber. It can be entered with the submarine at any angle. Being very small, it is flooded almost at once and after the two men have floated to the surface the upper hatch is closed again by gearing worked from the compartment, the chamber is drained into the bilges and the whole process is repeated. None of the personnel is thus under pressure except for the very short time taken to float to the surface.

There are a large number of photographs, which contribute greatly to a correct understanding of the appliances used and the problems involved in submarine operations.

The Measurement and Control of Temperatures in Industry. By R. ROYDS, M.Sc., M.I.Mech.E., London. Constable and Co., Ltd., 12, Orange Street, W.C.2. Price 25s.

THE author says in his preface that important developments in the standardisation, measurement and control of temperature in industry necessitated revision of his earlier work, *The Measurement of Steady and Fluctuating Temperatures*, and that the scope of the revised volume is more adequately described by the present title. Presumably then the book is mainly intended for industrial engineers.

The introductory chapter describing the bases of the standard temperature scales is brief and clear. In marked contrast, however, the next chapter on expansion thermometers is unnecessarily long, containing much information that an engineer does not need. Why, for example, does Mr. Royds consider the testing of the uniformity of bore of a mercury in glass thermometer to be of such importance as to merit description twice within six pages?

The next chapter discusses electrical thermometers and pyrometers. The operating principles of resistance thermometers and thermocouples are clearly set forth, together with descriptions of various commercial indicating and recording instruments. Considering that this is essentially a practical book, insufficient attention is given to errors likely to arise from contamination of thermocouples and methods of avoiding this defect. In fact, a reader might easily get the impression from parts of this chapter that contamination can only occur with iron, nickel, palladium and their alloys and that platinum/platinum-rhodium are free from this trouble at high temperatures.

The chapter on radiation pyrometers follows the pattern of the previous one, giving first elementary descriptions of the operating principles of radiation pyrometers, followed by detailed description of manufactured instruments. In view of the author's claim to have revised the book in the light of recent developments, his references to pyrometry practice in the steel industry are very unfortunate. For at

least ten years, British steelmakers have been measuring the temperature of molten steel in furnaces by means of the quick immersion thermocouple developed at the N.P.L. by Schofield and Grace, and this British invention is now being used in every important steelmaking area in the world. Yet Mr. Royds tells us that steelmakers have to measure the temperature of steel by sighting an optical pyrometer on the stream leaving the furnace, adding rather plaintively that it would be much more satisfactory if the temperature could be measured before tapping.

A considerable proportion of the chapter entitled "Galvanometers, Indicators, Recorders and Controllers of Temperature" is devoted to automatic temperature control, the author rightly stressing the importance of this subject. But here again the author has not lived up to his claim to have included important developments in standardisation. In 1949 the British Standards Institution sought to clarify the confused terminology used in discussing automatic controls by issuing a glossary of standard terms, but Mr. Royds has apparently ignored the existence of this.* He uses a most unorthodox terminology, which is bound to confuse many readers; in particular his use of the fundamental expression "controlled condition," which in this book surely should be temperature, is very puzzling.

In contrast to the criticism of the earlier chapters, it is pleasant to be able to write that the chapters dealing with the measurement of mean and rapidly fluctuating temperatures in metal walls are much more satisfactory. The author is obviously on familiar ground here. He gives detailed descriptions of methods that have been used for measuring the temperatures of such things as cylinder walls, pistons, boiler tubes, cutting tool edges, &c. The large number of references to original papers adds considerably to the value of these chapters to those people interested in this application of pyrometry.

To summarise, we think it a pity the title was changed as the original gives a better indication of the useful scope of this book.

Gas Turbine Theory. By H. COHEN and G. F. C. ROGERS. London: Longmans, Green and Co., Ltd., 6 and 7, Clifford Street, W.1. Price 30s.

THIS book is stated in the preface to be primarily intended for students and to form a bridge across the gap between a lecture course and technical articles. It will be appreciated that it is too mathematical and academic to be read without mental effort. On the other hand, it does not attempt to tackle problems of fluid flow and the like in their fully generalised complication. The work covered is first a consideration of ideal cycles, which, it may be remarked, gives somewhat misleading ideas for practical cycles. This is followed by an elementary consideration of gas dynamics before going on to the problems of practical turbine cycles. Centrifugal and axial compressors are then dealt with, combustion systems and axial flow turbines. The final chapter is on the prediction of the performance of simple gas turbines.

The authors state that they have avoided controversial topics. In fact, they appear to adhere to a somewhat narrow school of thought and ignore many other ideas. Their experience and attitude of mind are confined apparently to aircraft designs of the "Power Jets" school. Neither the exposition nor the references go far outside this restricted field. One would have thought that since the book is intended primarily for students, it would be as well for them to have had their eyes opened, at least by references, to the notion that the gas turbine is not a peculiarly British development and that some successful designs owe nothing to aircraft. It is notable that there is no reference to Stodola or the Zurich school, and only one reference to American literature, and that to an English author.

It is unfortunate that the authors use throughout the CHU despite the fact that many universities have agreed to drop the crusade in favour of such cross-bred units. It may be as well to point out also that there is no more scientific virtue in degrees Kelvin than in degrees Rankine, and much more practical sense in thinking in terms of degrees Fahrenheit or Celcius. Similarly, the symbols are those employed by Ewing and are not in line with present British Standards. These misdirections will necessarily result in a certain initial handicap to students, studying the book, who, when they enter industry, will find not only that they must acquire familiarity with workshop requirements and the compulsion of costs, but also they cannot speak the language of industry either in symbols or dimensions. The use of Greek letters is a legacy from the days when Greek was a sign of education, but as few engineers now learn Greek (or even the alphabet) and Greek symbols are not found on a typewriter, there seems a good case for abolishing them unless they are retained merely to impress the vulgar. On the other hand, punctilious use of English is an ideal worth striving for, in which the authors fail in some degree. For example, the use of "stressing" to mean calculation of stresses is a colloquialism permissible possibly in speech, but hardly in serious writing.

*This may be yet another out of many examples that could be quoted of the harmful effect of printing and publishing delays in preventing authors from presenting fully up-to-date information.—ED. THE E.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

ACCELERATION AND VIBRATION

SIR,—In your issue of April 11th last there was a review of the second edition of D. Laugharne Thornton's book, *Mechanics Applied to Vibrations and Balancing.* The reviewer made a statement that the author did not appear to be aware of the physiological fact that it was not the rate of acceleration, but the rate of change of acceleration, that determined the unpleasantness of vibration.

This seems to be very far from the truth as far as I have been able to ascertain, and taking the Joint Airworthiness Committee threshold of unpleasantness curve as a basis, the rate of change of acceleration shows a range 200 to 1 between 10 cycles and 100 cycles per second, whereas your reviewer implies that this should be a constant value. In general, it seems that the human frame responds more or less in one piece to vibration below about 10 cycles per second, and the threshold of unpleasantness runs along a line of constant acceleration in the region of $\pm 0{\cdot}05$g. Above 10 cycles per second the body will stand higher accelerations without discomfort probably because it responds as a transmission line and permits attenuation of the vibration with distance from the point of contact.

D. M. CORKE
Assistant Chief Vibration Engineer
De Havilland Propellers, Ltd.,
Hatfield,
May 19th.

LOCOMOTIVE EXPERIENCES

SIR,—In THE ENGINEER of October 13, 1939, you found room for a letter headed "Scottish Locomotive Experiences," stating my appreciation of articles on locomotive performance by Mr. Livesay then appearing in your journal. The letter concluded, "In any case, I shall always be pleased to see his contributions in THE ENGINEER."

I can safely say I have never felt inclined to retract that statement, though I did not expect to have occasion to quote it thirteen years later. Mr. Livesay's articles, as I said in that letter, are unique. His style is individual to himself. It is pleasant to read, even humorous, never "stodgy," nor overweighted with largely superfluous trivialities which tell one little or nothing, yet the facts are there. I am glad to notice no sign of staleness. His articles are as vivid and alive—again to quote my old letter—as ever.

I gather from your correspondence columns that Mr. Livesay is visiting, or has visited, England, and I am sure many of your readers will agree with me when I express a hope that he has taken the opportunity of looking into post-war locomotive performance in this country, and that he will have something to say in due course about his experiences.

JAMES STOKES

Wembley, May 9th.

[Indeed, he will!—ED., THE E.]

BOOKS RECEIVED

Industrial High Vacuum. By J. R. Davy. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 25s.

British Made Products in Stainless Steel. Edited by C. H. W. Roles. London: The Eagle Press, Ltd., 32, Great Queen Street, W.C.2. Price 10s. 6d.

All-Purpose Diesels. By J. Malcolm Robson. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 50s.

African Press and Advertising Annual, 1951. Edited by Chas. R. Pask. South Africa: 604, Boston House, Strand Street, Cape Town. Price 20s.

Foundations of Wireless. Fifth edition. By M. G. Scroggie. London: Iliffe and Sons, Ltd., Dorset House, Stamford Street, S.E.1. Price 12s. 6d.

Electrical Engineering Economics, Vol. 2. Second edition, revised. By D. J. Bolton. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 30s.

Aerodynamics of Supersonic Flight. By Alan Pope. London: Sir Isaac Pitman and Sons, Ltd. Pitman House, Parker Street, Kingsway, W.C.2. Price 25s.

A Practical Manual of Rubber Hardness Testing. By A. L. Soden. London: MacLaren and Sons, Ltd., Stafford House, Norfolk Street, W.C.2. Price 6s. 6d.

Electrolytic Polishing and Bright Plating of Metals. Second edition. By S. Wernick. London: Alvin Redman, Ltd., 4, Fitzroy Street, Fitzroy Square, W.1. Price 30s.

Industrial Administration and Management. By F. L. Meyenberg. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 35s.

Fellowship of the Air, Jubilee Book of the Royal Aero Club. By B. J. Hurren. London: Iliffe and Sons, Ltd., Dorset House, Stamford Street, S.E.1. Price 30s.

Aircraft Engines of the World, 1951. By Paul H. Wilkinson. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 50s.

Synthetic Resins and Allied Plastics. Third edition. Edited by R. S. Morrell. London: Oxford University Press, Amen House, Warwick Square, E.C.4. Price 50s.

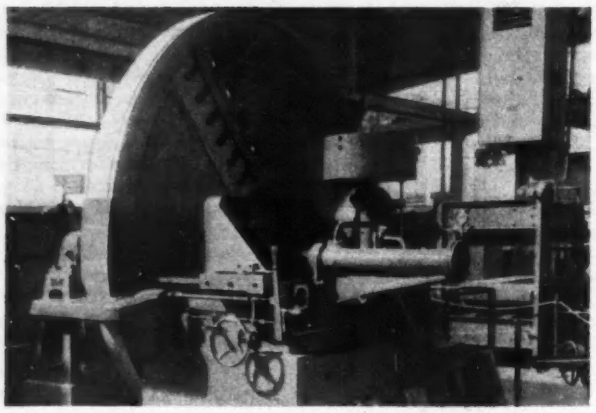
Magnetic and Electrical Methods of Non-Destructive Testing. By D. M. Lewis. London: George Allen and Unwin, Ltd., Ruskin House, 40, Museum Street, W.C.1. Price 35s.

Positive-Displacement Pumps and Fluid Motors. By Warren E. Wilson. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 40s.

Hanover Technical Fair

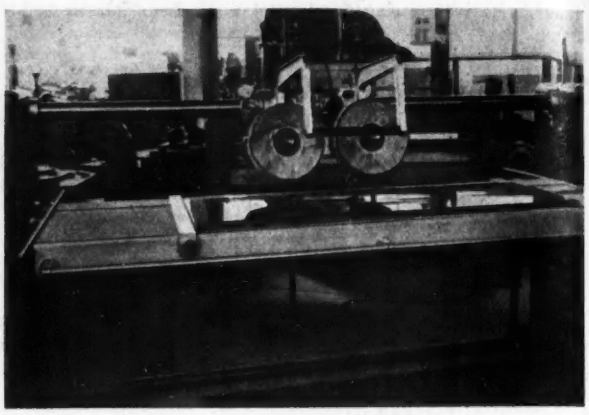
No. III—(*Continued from page 704, May 23rd*)

THE necessity to take care of the stocks of home-produced wood in Germany has revived interest in the rotary wood slicing machine, of Ortmann design, an example of which was shown on the stand of the Industrie Companie Kleinwefers Handelsgesellschaft m.b.H., of Kölner Strasse 43, Krefeld. As shown below, the machine consists essentially of a large flywheel disc, 8ft 8in in diameter, which carries the pair of cutting knives 33in in length. The machine is designed to cut material in thicknesses from $\frac{1}{32}$in up to $\frac{5}{8}$in at high speeds. Before the timber is cut it is steamed and afterwards dried. After setting up the knives the log is put on the table of the machine and advanced towards the disc by oil hydraulic feed gear. A weighted piston supplies the hydraulic pressure for table feed and the hydraulic unit is coupled to a brake gear. The main machine drive is by a 12 h.p. electric motor through a tensioned pulley to the face of the disc, which is driven at 90 r.p.m.



ROTARY WOOD SLICING MACHINE

For some time past the "Schwabbel" polishing process has been used in the radio industry with success, and it has now been extended to the furniture manufacturing industry and shipyard practice. On this page we show a large wood polishing machine designed by Cark Rückle, of Lange Strasse 7, Stuttgart, N, in collaboration with the varnish and lacquer producing firm of Theodor Votteler, of Münchingen-Stuttgart. The polishing coatings in this process are sprayed hot, and only two sprays are required, as against four needed with cold spraying. The machine has two buffs of flannel, which are rotated in opposite directions by 1 h.p. built-in motors running at 1000 r.p.m. The diameter of the buffs is 350mm; each polishing head runs in ball bearings and can be inclined to any desired angle. The work table is 2·5m in length and 1m wide. It is covered with felt and can be raised and lowered by hand.

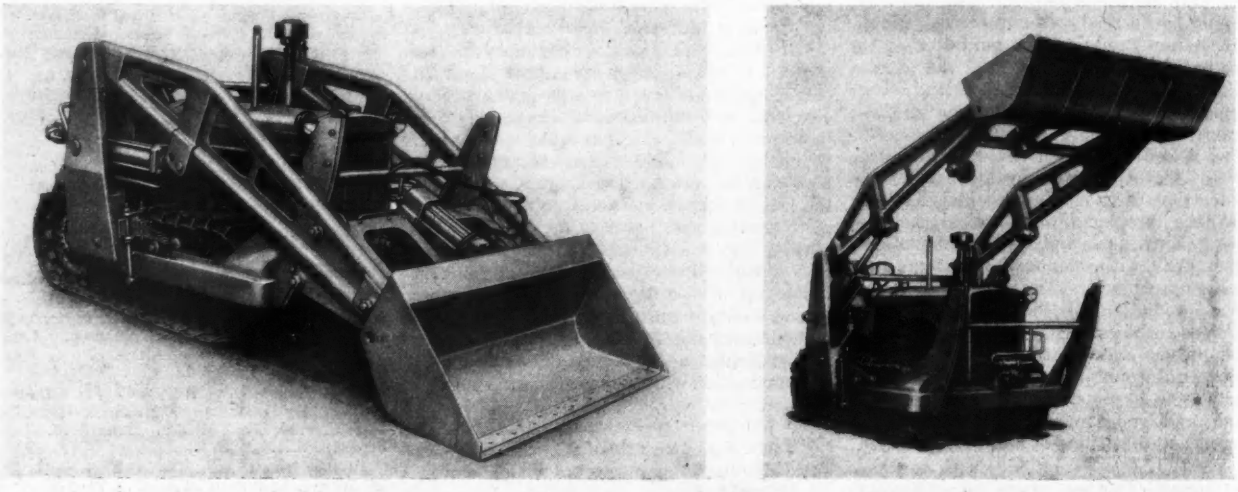


WOOD POLISHING MACHINE

The large number of building machines now being made in Germany and exhibited by various firms, is an immediate result of war damage and the rebuilding process which has been going on in the country for the last three or four years. Amongst the manufacturers of machines for ground clearance purposes the Hannoversche Maschinenbau A.G. (Hanomag), showed a variety of bulldozers and angledozers. The basic unit of these machines is the tracked tractor, powered by a 55 h.p. four-cylinder diesel engine, as a vehicle originally designed for heavy agricultural work. The hydraulic system of this machine is supplied by a motor-driven pump and all control levers can be operated from the driver's seat. A bulldozer shown was designed for a maximum cutting depth below ground of 8in and a lifting height above ground up to 18in. On it the cutting angles can be adjusted in accordance with the grade of resistance offered by the various kinds of soil.

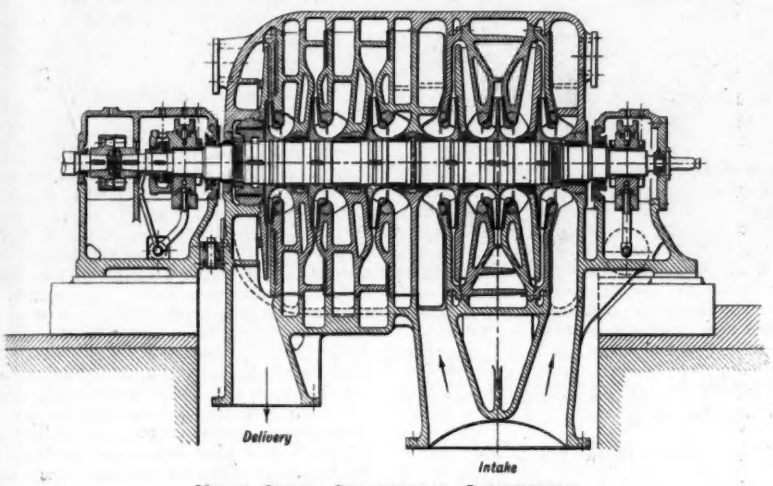
Another interesting machine, also based on the 55 h.p. tracked tractor, is a combined unit primarily designed as a "shallow dredger" for levelling work. The blade can be exchanged for a tiltable shovel, thus transforming the leveller into a front loader, capable of lifting 3300 lb to a maximum height of 11ft as illustrated below.

A useful machine for levelling large building sites, erecting dykes and building roads is the grader, which was shown at the stand of Orenstein and Koppel, of Berlin. This six-wheeled machine (page 737) equipped with pneumatic tyres of 13.00–24 size, is powered by a 95 h.p. diesel engine. The torque is transmitted to the two live rear-axles through a hydraulic coupling and a six-speed gearbox; an additional gear allows the use of all six speeds in the reverse direction. The 13ft long blade can be turned in the frame to any desired angle by a mechanical drive, taken off the main gearbox. The blade can also be lifted and lowered, shifted sideways, and tilted for the cutting of trenches. All adjustments of the blade are effected by mechanical drives from the gearbox and are controlled



55 H.P. TRACTOR FITTED WITH COMBINED PLANER AND FRONT LOADER

SIX-WHEELED GRADER



MULTI-STAGE CENTRIFUGAL COMPRESSOR

by hand levers from the driving seat. The steering of this heavy machine, which weighs 15 tons, is assisted by a hydraulic servo-motor.

For working on ground which is very heavy or contains stones or roots, tines can be attached to the frame, in front of the planing blade. Like the blade itself, they can be lifted or lowered by a mechanically operated gear.

The diesel engine of the grader is made by Orenstein and Koppel. It is a six-cylinder, swirl-chamber engine of 115mm bore and 160mm stroke, with the cylinders arranged in vee 60 deg. form.

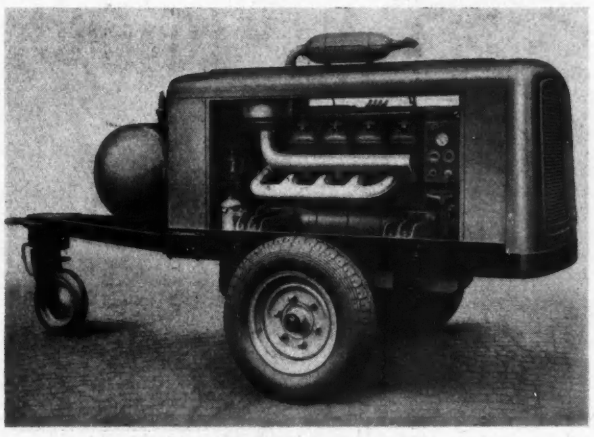
Another exhibit at the same stand was the "universal compressor tractor," (illustrated below), the four-cylinder, 40 h.p. diesel engine of which can be used as a compressor by the simple expedient of employing two cylinders as compressor cylinders. A lever, operating a valve in each of these two cylinder-heads, effects the changeover from engine to compressor operation; the engine then runs on two cylinders, developing 32 h.p., and the compressor part delivers 110 cubic feet of free air at a pressure of 85 lb per square inch. The tractor also carries a welding generator of 9kW (30V by 300A), driven by an auxiliary shaft from the gearbox. Apart from welding, the generator can be used for cutting operations, in which case "Arcos-Oxyarc" electrodes are employed. With it plates up to 1⅛in thick can be cut. The oxygen required for this process is supplied by two cylinders, carried on either side of the driving seat. The welding generator can also be used as a lighting set by adjusting the voltage to 60V and the machine is then capable of supplying the current for fifty 100W lamps. If required, a motor-driven cable winch with a pulling effort of 3 tons can be fitted.

The use of combined diesel-engine air compressor sets is becoming popular in Germany, especially for light portable units of about 100–150 cubic feet delivery. Several kinds of these compressors were shown at the stand of the Frankfurter Maschinenbau A.G., formerly Pokorny and Wittekind. A unit was shown, comprising two direct-injection diesel cylinders, mounted on either side of the compressor cylinder, the delivery amounting to 100 cubic feet of free air at 110 lb per square inch. In accordance with the firm's practice, the compressor cylinder is fitted with the so-called "tier valves," a series of annular valve seats and valve plates, arranged to form tubular units, which offer a large valve-opening area in spite of their comparatively small overall diameter.

Another diesel compressor unit, made by Irmer and Elze, of Bad Oeynhausen, is worthy of mention. It consists of an air-cooled Deutz diesel engine in which half of the number of cylinders are converted into compressor cylinders by the application of new cylinder heads, containing combined suction-delivery valves. The biggest air-cooled unit built by the firm to this design is illustrated below. It was developed from the eight-cylinder vee 90 deg. Deutz engine. The four-cylinder engine part has an output of 60 h.p., while the four compressor cylinders deliver 200 cubic feet of free air at 85 lb per square inch. Air-cooling of single-stage compressors with a cylinder bore of 110mm is rather unusual but the manufacturers claim that this arrangement has proved satisfactory. The complete unit weighs only 3½ tons.

Among the large compressors a multi-stage centrifugal unit, built by the Gutehoffnungshütte, of Oberhausen, was interesting in that external water-cooled intercoolers are used between each stage, except the first low-pressure stage. The accompanying longitudinal section of a five-stage compressor illustrates the principle. Air enters the two single-sided impellers of the first stage through a bifurcated intake and then flows through a diffuser to the double-sided impeller, between the two impellers of the first stage. The three impel-

COMBINED TRACTOR AND COMPRESSOR



PORTABLE AIR-COOLED DIESEL COMPRESSOR

lers form the low-pressure part of the compressor, which is free from any axial thrust. From the low-pressure part the air flows through a double-scroll diffuser and an intercooler to the high-pressure stage, which may consist of up to five or more single-sided impellers with intercoolers placed between them. All intercoolers are of tubular design and are accessibly mounted on each side of the compressor casing. Because of the very intensive intercooling between the stages and the short air passages which offer little resistance to the air flow, the compression ratio of each individual stage can be kept rather high, resulting in greatly improved adiabatic efficiency. A further advantage of this design is that high speeds, up to 10,000 r.p.m., can be employed, with a comparatively short and small diameter rotor assembly. The overall dimensions and the weight of the new compressor are also smaller than those of machines of orthodox design.

The compressor, exhibited at the Gutehoffnungshütte stand, had two low-pressure and five high-pressure stages and was designed for a delivery of 10,500 cubic feet per minute at 100 lb per square inch. The compressor speed is 9450 r.p.m. and the speed of the input shaft, running at 1500 r.p.m., is stepped up in a compact epicyclic gear, made by Fr. Krupp of Essen.

A Lock at Newark-upon-Trent

The lock at Newark-upon-Trent which has recently been opened is thought to be the only major structural improvement for inland navigation which has been completed in this country since the war. It is nearly 200ft long by 30ft wide, and gives a rise in level of about 6ft. The lock walls are of steel sheet piling and the work has included the construction of a mole and the diversion of the river channel to remove a sharp bend.

A MODERN lock has recently been built by the Docks and Inland Waterways Executive at Newark-upon-Trent, to facilitate the movement of traffic on the Trent Navigation between the Humber and the Nottingham area. The lock was opened on April 18th and it is thought to be the first major structural improvement carried out on any inland waterway in this country since the war.

The new lock will be able to pass in one operation a unit of four standard Trent craft carrying about 500 tons, or a large single craft of 200 to 250 tons capacity, according to the cargo. The old lock could deal only with single standard Trent craft, but the new lock will enable the larger craft, including oil tankers, to extend operations up to Colwick. Later, when certain other work has been done, they will be able to reach Nottingham.

The new lock is situated to the north of and parallel to the old Town Lock. Its upper limit is the entrance to a dry dock and in consequence the lower end of the lock projects into the River Trent. At this point the river made a sharp left-hand bend of some 130 deg. and in order to obtain improved conditions of flow, some river diversion was essential. This allowed the northern wall of the lock to be carried forward in the form of a mole to provide a " lead in " for vessels navigating upstream and a sheltered mooring for vessels waiting to enter the lock. A new hauling path bridge was necessary to maintain a public right of way, and the most suitable position was considered to be from the end of the mole, spanning the diverted river channel. The extent of the river diversion can be clearly seen in the illustration opposite, with the mole and reclaimed ground to the left of the footbridge, and the slope of the new river channel visible near its abutment on the right hand side. The principle dimensions of the new lock are given in the accompanying table.

Length, hollow quoin to hollow quoin	192ft 10in
Width between fenders	30ft 2in
Width at gates between concrete walls ...	30ft 4in
Depth over inner and outer sills at S.W.L. ...	8ft 6in
Rise at O.S.W.L.	6ft 3in

Bore Hole Tests

Four bore holes were sunk at the site and soil testing was carried out to obtain accurate information on which to base the design. The main formation of red marl was found under a layer of gravel, which was overlain by typical river silt in three borings and by a sandy clay in the fourth boring. The top layer was formed in all borings by made-up ground.

The ground water level in all borings corresponded approximately to the water levels in the neighbouring canal, basin or river, or rose to these levels as soon as water was struck in the river silt or gravel. The made ground varied from place to place and could only be considered as a surcharge. The river silt varied in thickness from 2ft to 6ft 6in and was regarded as an original deposit of relatively recent age, being very wet and soft, composed of a clayey silt with large peaty enclosures and a considerable amount of organic matter. Its bearing capacity was considered negligible. The gravel layer had a thickness of 6ft to 10ft and was a sandy gravel well graded and of high bearing capacity suitable for sheet pile anchorages. The red marl, the surface of which varied from +16·67 O.D. to +19·43, was not a uniform stratum, being composed of layers of plastic clay and of shale. At certain places it appeared to be slightly granular and in one sample the chalk content was determined as approximately 20 per cent of the total dry material. Accordingly, though it appeared rather cohesive it was not regarded as impermeable, particularly not in thin layers. The shaley nature of some layers made it impossible to obtain really undisturbed cores and the shear strength of the marl was assessed on recompacted samples with larger stony portions of the shale removed. It was considered that the marl was not a suitable material to form the lock bottom because a slow plastic deformation would lead to gradual disintegration.

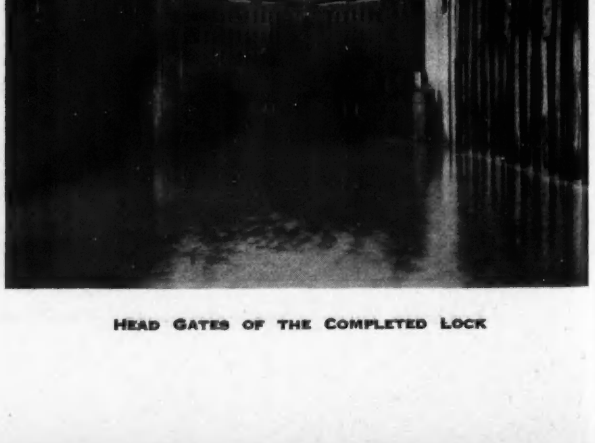
Design and Construction

The lock was designed with tied steel sheet piling forming the lock walls, with a concrete coping. The two gate chambers were each constructed inside a steel sheet piled cofferdam, to guard against the possibility of flooding from the river or from a " blow " in the bottom. Inside each of these cofferdams the gate chambers consisted of mass concrete gate recesses, with the walls extended to incorporate stop grooves and sills above and below each gate, thus avoiding the complicated cofferdam design usually necessary when constructing small reinforced concrete pillars for the reception of gates. One of our illustrations shows the construction of the lock in progress; three 15ft lengths of the invert have been placed in this illustration and the cross dam on the inner side of the head gates chamber has been burnt off and removed.

In order to maintain a method of emptying and filling the lock similar to that at the other Trent locks, it was decided to fit sluices to each gate leaf and not construct wall culverts, although the mass concrete gate chamber walls could readily have contained culverts in the wall around each gate.

The steel piled walls of the lock body and the gate cofferdams were designed as propped cantilever walls with one line of walings tied back to steel sheet piled anchor panels. The " deflection line method " used in the design requires the following conditions to be fulfilled: the sum of moments about the tie rod connection to be zero; the summation of loads on one side of the wall to equal the summation of loads on the other side; there should be

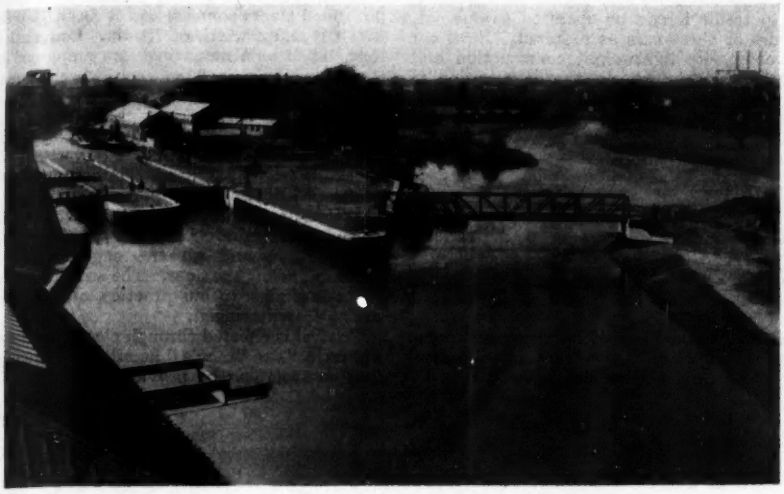
CONSTRUCTION OF GATE CHAMBER AND INVERT



HEAD GATES OF THE COMPLETED LOCK

no deflection at the tie rod connection; a vertical line passing through the tie rod connection to be tangential to the deflection curve at the toe of the wall. The mass concrete invert was designed on the virtual arch principle and vents were considered a necessity, particularly whenever the lock was to be dewatered for repairs, so that relief could be provided for upward water pressure.

The concrete gate chamber wall was designed on the assumption that a 15ft length of wall above the hollow quoin acts as a monolith with the length of wall below the hollow quoin; the latter length not exceeding 15ft in the calculation. Below the gate it was assumed that the lock was dewatered. The stability of the wall was checked in two directions; normal and parallel to the centre line of the lock, and the effect of the earth pressure and the support offered by the steel sheet piling were neglected.



NEWARK-UPON-TRENT LOCK LOOKING UPSTREAM

The cofferdams of the gate chambers, the lock body and pierheads are constructed in No. 3 section Larssen steel sheet piles, 27ft 6in long; the mole and the old lock side of the inner pier are constructed in No. 2 section piles, 27ft 6in and 20ft long. The piling is connected to anchor panels formed in No. 3 section piles, 15ft long, by 2¼in diameter mild steel tie rods, generally spaced at 7ft 10½in centres. The walings are formed of two steel channels, 9in by 3½in. Precast concrete coping 3ft wide and 18in deep are set on top of the piles forming the lock body and mole.

Excavation of the dumpling and the invert of the lock chamber was carried out after the piles had been driven and, because of the probability of the water-bearing strata exerting severe pressure on the piling before the invert had been concreted, the ground water level was lowered by installing a system of well-points. Fifty-one well-points were jetted down and connected to a 6in diameter ring main from which air was evacuated, and the water discharged by a well-point unit, duplicated in case of failure, comprising an air vacuum pump and centrifugal pump directly coupled to a diesel engine. Despite the short distance from the river and the old lock, the lowering of the water table was a success and there was no evidence of the abstraction of fines.

The 6 to 1 concrete invert was laid in consecutive strips 15ft wide on a sound marl formation providing adequate bearing. The invert of the lock chamber is 3ft thick, ten vents being formed in the invert to relieve any upward water pressure. An interesting item in the construction of the vents was the use of 2ft diameter porous concrete pipes, which extend below the concrete invert into the marl. A 3in by ¼in angle was welded to the face piles as a connection between the piling and the concrete to give the necessary shearing resistance in the event of upward water pressure.

The lock gates are of timber. The heel and mitre posts and certain beams subjected to heavy loading are of greenheart; other beams are of oak, whilst the gate fenders are of wych elm. Each leaf has two sluices, each 3ft by 2ft operated by one sluice box on the footboard. Each gate is opened and closed by a racking arm in gear with a manually-operated standard. Dutch elm sills at an angle of 25 degrees are fixed to the concrete by means of lewis bolts and wedges for easy renewal.

The cast iron hollow quoins, cast as part of a circular pipe with flanges mated by dowels and bolted together in unit lengths, are held in position by bolts screwed into "cement-in" sockets for easy replacement. When repairs are necessary, horizontal timber stop logs, housed in the stop grooves formed in the side walls, will be supported by vertical steel joists housed in pockets in the invert and attached at the top to a horizontal girder placed in recesses near coping level.

As shown in one of the illustrations, vertical fenders of Douglas fir faced with oak rubbing pieces are fitted into the steel piles and the pierheads are backed in mass concrete.

The bridge, which has a clear span of 82ft, is of conventional design in light lattice girder steelwork with a reinforced concrete decking. Box piles provide the necessary support at each abutment.

The estimated cost of the works, which took seventeen months to complete, was £64,114. The contractor was Chas. Brand and Son, Ltd. The lock gates were constructed and fitted by the North-Eastern Divisional Staff of the Docks and Inland Waterways Executive. The whole of the works were designed and executed under the supervision of Mr. G. R. Fenton, divisional engineer, North-Eastern Division, Docks and Inland Waterways Executive.

The Opening of a Dry Dock at Barry

On Friday, May 16th, the reconstructed Barry Commercial Dock at Barry, in South Wales, was officially opened. Work on the reconstruction is now completed and the dock will be known in future as Bailey Dry Dock. The old arrangement consisted of two dry docks which could accommodate four vessels at the same time with single shoring only. The outer dock measured 360ft and the inner dock 420ft, with a dividing caisson in the middle and although the dock was 113ft wide at cope level, the entrances were restricted to a maximum of 55·5ft, thus rendering the dock obsolete for modern vessels.

The dry dock is now the largest in the South Wales ports, its length being 940ft, divided by a middle caisson. With the middle caisson in position, the outer dock is 445ft long and the inner dock 477ft long. The width of the new entrance is 76ft 6in at sill level and 78ft 6in at cope level, and the width of dock at cope level is 99ft 6in. Thus, it will accommodate two modern cargo vessels at the same time, or the largest vessel that is able to come into the port. Among the novel features introduced into the reconstruction may be mentioned the setting forward of one of the dry dock side walls by means of mock altars, and the construction of the caisson gates on the site, as described in our issue of January 11th last. The dock is non-tidal and the draught over the sill is maintained at 21ft 6in minimum. This draught can be increased when necessary to 25ft 6in.

The crane facilities include one 25 ton monotower electric travelling crane, operating from the west side of the dock and capable of lifting 8 tons from the east dock side. There is also one 11 ton diesel-electric travelling crane and one 12 ton and one 3 ton steam cranes. These cranes travel all round the dock. Maintenance and repair facilities include supplies of oxygen and acetylene, compressed air and steam; welding points are fitted at intervals round the docks and in the shops. Adjacent to the dry dock is a repair berth 600ft long with a 12 ton portable electric travelling crane. Pipe-lines have been installed from the repair berth to a tank farm about 300 yards away to handle light and heavy fuel oils, and the removal of sludge. The sludge will be separated with two separators, each with a capacity of 150 tons per hour.

The reconstruction work was carried out for C. H. Bailey, Ltd., the lessees of the dock. The consulting engineers were Messrs. Maunsell, Posford and Pavry, and the contractors John Howard and Co., Ltd.

Indian Port Developments

In 1946 the Ports (Technical) Committee emphasised the need for a major port between Karachi and Bombay, in the Gulf of Kutch, and recommended Kandla as the promising site for the purpose. Another committee, the West Coast Major Port Development Committee, set up by the Government of India, also came to the same decision and the recommendation was accepted by the Government. A development commissioner, responsible for co-ordinating the various activities connected with the development of the port, the railways and township, was appointed, together with an advisory committee and a chief engineer.

The construction of the main harbour works, the foundation stone of which was laid by the Prime Minister, Mr. Nehru, on January 10th this year, is expected to be completed within a period of three years. The main harbour works will be carried out by contractors, while the construction of quarters, roads, bridges, &c., within the port limit will be undertaken departmentally. Steps are also being taken to link Kandla by railway with the Western Railway. Kandla will be linked with Deesa on the Palampur-Deesa branch line and Deesa with Raniwara on the Samdari-Raniwara line. The construction of the Kandla-Deesa section has been started and is likely to be completed by October, 1952. On completion of the harbour works and the railway connection mentioned above the port may be called upon to handle 300,000 tons of imports and 150,000 tons of exports and 400,000 tons of oil. Its completion will to some extent reduce the pressure on the port of Bombay and reduce substantially the rail loads to and from the hinterland covering Central India, Rajasthan, Delhi and East Punjab. The project is estimated to cost Rs. 12·95 crores.

Experimental Lightweight Diesel Train

BY arrangement between British Railways and A.C.V. Sales, Ltd., trials are being carried out between London (Marylebone) and Princes Risborough of an experimental British-built lightweight diesel train (illustrated herewith), which has recently been built by A.C.V. Sales, Ltd. The facilities afforded by British Railways for these trials form part of a special study which the Railway Executive is already making of the possibilities of light units generally for developing traffic, and for working it more economically, both on branch line and on suitable main line services. As part of the same policy an improved design of steam "push-and-pull" train is being tried out in the Western Region, on the Ealing and Greenford service. Following the present service trials of the A.C.V. demonstration train, it will be used experimentally on public services on outer London suburban routes during "off-peak" periods.

The basic principle of the experimental train is the application to a railway vehicle of selected characteristics of bus and coach design. The power unit, excluding the final drive, is, in fact, identical to that mass produced for several bus companies, including the Green Line buses in London. The vehicle enjoys also the great advantage which a railway vehicle possesses in its much lower rolling resistance and the easier gradients which it uses. The design has aimed, overall, to combine the best features of both rail and road vehicles, and which, apart from its possible use in the British Isles, will, it is hoped, prove capable of development for the export field. Compared with a normal railway coach 60ft long and weighing 30 tons, one of the motor cars of the lightweight train, plus one trailer, has a combined length of 80ft, and including all power units the weight is only 25 tons. In other words, these vehicles, though having 20 per cent more space, weigh 15 per cent less, quite apart from locomotive weight. In slack periods the motor car can shed its trailer and so reduce the weight to 15 tons, while retaining a capacity equal to the traffic available.

Other advantages emphasised by the manufacturers for this lightweight train include its quick turn-round at stations, as it can be driven from either end; low wear and tear and maintenance costs are expected due to the lightweight construction; there is no fuel burned while the train is not actually in operation, and the fuel consumption under variable service conditions is only about 11 miles to the gallon for each power car, or 5½ miles per gallon for the three-car train.

Description of the Train

The train as demonstrated on Friday last comprises a three-car set, but to meet fluctuations in traffic it can be operated as one car, two cars or three cars as required. Each car is of composite lightweight construction and is carried on four wheels, the composition of the train being :—

	Passenger seats	Length over buffers Ft in	Unladen weight T c q
Car No. 1, motor car (with compartment for guard and luggage)	32	40 3	14 13 1
Car No. 2 trailer	52	40 3	10 9 3
Car No. 3 motor car	45	40 3	14 11 0
Totals	129	120 9	39 14 0

Cars Nos. 1 and 3 have driving compartments at either end; all three cars have central passenger doors on either side.

LIGHTWEIGHT DIESEL TRAIN

While the body shell is standard for all three cars, it was shown how interior arrangements can be varied to suit individual requirements. As all power units are below floor level, the whole of the space above this level (except for the driver's cabs) is available for passengers and luggage.

The steel underframes and engine units were made in the A.E.C. Works, Southall, Middlesex, and the bodywork at the Park Royal Vehicles, Ltd., another A.C.V. company. Each motor car is powered by a six-cylinder diesel engine. This engine as well as other mechanical details of the car is identical with those used in the latest design of Green Line omnibuses and develops 125 b.h.p. at a maximum of 1800 r.p.m. Power is transmitted to the wheels through a fluid flywheel and a four-speed epicyclic gearbox.

This flat horizontal engine is mounted underneath the floor. Its bore is 4·72in, stroke 5·59in, and it develops a maximum torque of 430 lb per foot. The gearbox provides for gear ratios 4·5 : 1, 2·53 : 1, 1·64 : 1, and 1 : 1, and the drive is taken through universal joints to one axle of the car, which is mounted on four wheels. This final drive incorporates a double reduction and reverse mechanism, the bevel ratio being 1·55 :1, the spur 2·62 : 1, giving a total of 4·06 : 1. The overall ratios at 1800 r.p.m. with maximum tractive effort in each gear are as follows :—

	Ratio	Speed, m.p.h.	T.E., lb
First speed	18·29	10·0	4700
Second speed	10·35	17·0	2670
Third speed	6·68	26·5	1720
Top	4·06	45·0	1110

Cooling is by a gilled tube radiator with a self-contained fan 19½in diameter running on a machined housing.

Chassis

A non-welded chassis is formed from 9in by 3in rolled steel channels, and it has a length of 37ft 6in and a width of 7ft 4in. Conventional horn block axle mountings are employed and the wheel base is 22ft, each wheel diameter being 2ft 10in.

The main springs comprise nine leaves, 4ft 6in long, 3½in wide, and rubber auxiliaries providing lateral damping and vertical fluid shock absorbers are fitted. Automatic vacuum brakes with two shoes per wheel fully compensated are employed, together with a screw-down hand brake. The body is of composite construction, and all the engine units are mounted below the floor. The seating arrangement is similar to bus practice, and the doors are at present hinged.

Control is effected through electro-pneumatic valves, a "dead-man's" handle being included, and controls can be provided at each end of the powered cars and the trailer car if required.

The utility purpose of these vehicles has been strictly maintained in order to obtain the utmost economy in first cost, maintenance and running costs. The noise level is, in fact, equal to that of the tube trains, which would, as the company points out, be reduced by the additional expense of insulation material placed under the floor. A heating system and powered sliding doors might also be supplied if required.

The controls are coupled through the train so that both motor cars can be driven simultaneously by one driver, as on an electric train.

The maximum speed is about 45 m.p.h., and preliminary trials have shown that the train has no difficulty in maintaining normal schedules on the class of work for which it has been designed.

ALUMINIUM DATA.—The Northern Aluminium Company, Ltd., has issued a booklet entitled "The Properties of Noral Alloys," which replaces the original data sheets circulated by the company. There are comprehensive general notes on the various alloys and these are followed by tables which give the chemical and physical properties of the company's alloys produced as sheet, plate, extrusions, tube, wire, forgings, and castings.

Missouri Valley Floods

(By our American Correspondent)

BETWEEN the Great Lakes and the Rocky Mountains lies a plateau which slopes steeply to the east. Coursing through the plateau are the source streams of North America's two great rivers—the Mississippi and the Missouri. In winter the plateau is one of the coldest areas in the United States—deeply covered with snows from October to March. In spring, when the snows melt, the waters muddy the ground and fill the rivers. This year spring came late to the plateau. About two months ago a warm wind, called a chinook, swept over the plains. The snow melted into torrents. The torrents poured over frozen ground into the rivers. The rivers swelled into floods. Recently both the Mississippi and the Missouri have been on the rampage. In the States of Minnesota, Wisconsin, Iowa and Nebraska the floods washed houses away and turned city streets into deep canals. Most publicised was the excitement in the twin cities of Omaha, Nebraska and Council Bluffs, Iowa, where, for four days, over 8000 men worked to build up the dykes. When, finally, the flood crest hit the twin cities, the dykes held. But over fifty cities and a million-and-a-half acres of farmland had been inundated. While the Missouri Valley floods of 1951, which reached a rate of flow at Kansas City of 510,000 cubic feet per second, were considered "catastrophic," those of 1952 have already been described as the worst in history.

The Missouri and its tributaries drain a basin of 530,000 square miles—one-sixth of the land area of the United States. From that basin comes half of America's wheat and rye, a quarter of her sheep and horses, and a sixth of her cattle and hogs. Yet, over and over again, the river floods millions of acres, drives thousands from their homes with loss of life, and destroys property worth hundreds of millions, while vested interests wrangle over dykes and reservoirs. The Missouri basin needs more than river control. Its great mineral resources should be developed intensively. It has forests that are a national asset. It needs electric power for rural electrification and for the energy requirements of potential industries. President Truman is unquestionably right in saying that "it's time for action" now; but the big question is, what kind of action? The worst thing that could possibly be done for the future of flood control in the Missouri Valley would be for a panic-stricken Congress, spurred on by the urging of the U.S. Army Corps of Engineers and local pressure groups, indiscriminately to approve more hundreds of millions of dollars for the construction of dams, dykes and the like without pausing to consider how the valley should be treated as a whole. Relief funds are essential; but planless public works are something altogether different. More than 1,500,000,000 dollars has already been spent on harnessing the Missouri since the last war. But what has been lacking is the prime essential: an integrated policy that balances the varying interests of flood control, navigation, irrigation, power development, recreation, &c. The well-known Pick-Sloan "plan," thrown together in 1944 as a compromise between the conflicting claims of the Army engineers and the Bureau of Reclamation as to who should do the construction work and for what purpose, is just about the only guide now in existence. But the Hoover Commission has dismissed it as "in no sense an integrated development plan for the basin."

For years the matter of Missouri Valley flood control has been an issue between Congress and the Administration. In the early 'forties, Administration supporters were advocating plans for a semi-autonomous Missouri Valley Authority—set up like the Tennessee Valley Authority—to plan and administer a comprehensive programme of dam building, soil conservation, power production and irrigation. Congress objected to this programme on the ground that it would give the Administration too much power in the vast valley. Now it has been reported that the President is planning to take flood control responsibility away from the Army Engineers and give it to the Department of the Interior. The President is expected to propose this change under the executive reorganisation programme. This means that the change will become law within sixty days unless a constitutional majority of either the House of Representatives or the Senate votes against the change. Even so, there are grave doubts whether the President's proposal will be accepted. Congress has always favoured the Army Corps of Engineers. Tragic as the results of this year's floods are, there is little prospect that any basic change in American policy for Missouri Valley flood control will be made amid the political tensions of an election year.

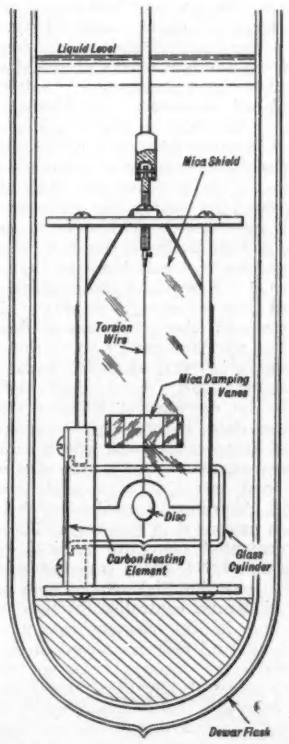
American Engineering News

(By our American Correspondent)

Hydrodynamic Properties of Liquid Helium II

Using a method similar to that employed by physicists in the nineteenth century to study ordinary sound waves, Dr. J. R. Pellam, of the National Bureau of Standards, recently developed an interesting and highly accurate mechanical technique for investigating "second sound," that unique, wave-like process of heat transfer occurring only in helium II near absolute zero. The new technique, known as the thermal Rayleigh disc method, makes use of the torque exerted on a light disc suspended in the path of standing waves of second sound. It is thus believed to constitute the first mechanical method for the detection of this phenomenon. The development not only provides an effective means for determining the velocity and intensity of second sound, which is of basic theoretical importance in low-temperature physics, but also appears to verify the presence of a superfluid in helium II and to open up an entirely new field of "quantum hydrodynamics" based on the peculiar heat-flow characteristics of this remarkable liquid. Helium liquefies at 4·2 deg. K., the lowest liquefaction temperature of any substance. Between the temperatures of 4·2 deg. and 2·19 deg. K., liquid helium behaves as a normal fluid, and in this state it is known as helium I. At 2·19 deg. K and below, however, helium I changes into the liquid form known as helium II. The characteristics of helium II are so unlike those of helium I or of any other fluid that it is often referred to as a fourth state of matter or as the quantum fluid. Thus it acts as though it has no viscosity, flowing, apparently without friction, through virtually vacuum-tight openings and up the side of a containing vessel at remarkable speed in seeming defiance of gravity. Its direction of flow through narrow orifices may be controlled entirely by the introduction of temperature differences. One of the unusual properties of helium II is its high thermal conductivity—3 million times that of helium I and much greater than that of any other substance. The remarkable properties of helium II and the phenomenon of second sound have been explained by mathematical theories which indicate that helium II consists of two kinds of fluids. One portion is a normal fluid, similar in nature to helium I; the other is a superfluid, which accounts for the unusual effects observed. The atoms of the superfluid have had their energies reduced by cooling to the point where thermal motion has ceased, yet the attractive forces between them are not great enough to produce a rigid solid. According to current theories, the application of heat to some part of a quantity of helium II upsets the equilibrium between the two fluids, resulting in a migration of the superfluid atoms from cold to hot while the normal fluid atoms move from hot to cold. As the superfluid is assumed to have virtually zero viscosity, a sustained internal vibration between the fluid components becomes possible, and this internal convection type of wave propagation constitutes second sound.

Since second sound is basically a "concentration wave," consisting of a progressive change in the relative proportions of normal fluid and superfluid at any point in the liquid, it has until now been detected only by temperature-sensitive devices, such as a bolometer. Neither pressure nor velocity microphones could be used because the two fluid components oscillate exactly out of phase, and there is no net transfer of mass or momentum. The thermal Rayleigh disc method for studying second sound is believed to be unique in that it utilises the mechanical forces produced by the streaming of the normal and superfluid atoms about a disc placed in the path of the waves. The elaborate electronic equipment previously required for research in second sound is thus eliminated. It will be recalled that the Rayleigh disc was originally developed by Lord Rayleigh in 1880 for detecting and measuring the strength of ordinary sound waves. Its operation depends on the tendency of a disc or other flat object when freely suspended to align itself crosswise to the direction of fluid flow. This tendency results from distortion of the stream lines of fluid flow about the disc, which causes differences in the pressure exerted on the disc by the fluid at various points. Since the torque exerted on the disc depends on the kinetic energy distribution of the fluid about the disc—i.e., on the square of the particle velocity—the direction of particle flow does not affect the torque exerted on the disc, and two opposing currents, such as are presumed to occur in second sound, do



THERMAL RAYLEIGH DISC APPARATUS

not mutually cancel. The principle of the Rayleigh disc was thus considered to be ideally suited to an experimental verification of the two-fluid theory of helium II. If, as has been postulated, helium II consists of a mixture of normal fluid and superfluid, and second sound consists of a two-way migration of superfluid and normal fluid atoms in opposite directions, then a light disc freely suspended in the path of second sound should rotate toward a position perpendicular to the path of the heat flow, even though there is no net transfer of helium II in either direction.

In the course of a continuing investigation of the low-temperature properties of matter at the N.B.S., a thermal Rayleigh disc apparatus was set up to determine experimentally the validity of these conclusions. In this apparatus a lightweight mirrored disc, $\frac{1}{4}$in in diameter, is suspended by a thin torsion wire at the midpoint of a horizontally oriented cylindrical glass cavity containing helium II. Standing waves of second sound are set up within this cavity when heat oscillations of the proper frequency are introduced by means of an electrically heated carbon resistor strip, which makes up one end wall of the cavity. The resonant cavity, the mirrored disc, and the suspension gear are all immersed in a dewar flask of liquid helium II enclosed in a vacuum system. The temperature of the helium is obtained from the pressure above the liquid as indicated by a manometer. Initially the disc is placed at an angle of 45 deg. to the direction of the flow of the waves of second sound. The small deviations of the disc from its initial equilibrium position at various temperatures and frequencies are then observed and measured by noting the resultant deflection of a light beam. The sharp response of the disc, as the system is tuned through resonance, verifies the existence of the internal mass flow of the two fluid components and the associated kinetic energy density. A light source projects the light beam down the axis of the resonant cavity on to the silvered disc, where it is reflected to fall in focus on a galvanometer scale. Very small deflections may thus be determined without difficulty. From these data, together with corresponding values of temperature and the geometry of the apparatus, the torque on the disc and the velocity and intensity of second sound are computed. Torques as small as 10^{-4} dyne-cm have been measured in this way. The mirror-disc is cemented along its vertical diameter to a thin metal rod, which is supported in turn by a flat 0·0015in thick copper ribbon. The metal rod hangs centrally through a small circular hole in the resonant cavity. Above this opening, and thus immersed in helium II but outside the resonant system, damping vanes composed of thin mica are cemented to the metal rod. A system very similar to that used for galvanometer suspensions is employed to protect the torsion ribbon from strain or shock when not in use. Only after the dewar flask system has been filled with liquid helium and cooled to helium II temperatures is the disc assembly raised to its operating position.

The experiments with the thermal Rayleigh disc have significant theoretical implications. In the first place, the response of the disc to the heat current known as second sound provides a convincing experimental verification of the two-fluid hypothesis of helium II. That the disc can detect these opposing currents which do not affect a microphone lends strong credence to the concept of the two fluids passing through each other in response to a difference in temperature between two points. Moreover, the amount of the measured torque and its variation with temperature correspond exactly with theoretical values computed on the assumption that the superfluid participates in the same streamline flow as do ordinary fluids. Of even more fundamental significance is the generalised duality which the behaviour of the thermal Rayleigh disc implies between the quantum thermomechanics of liquid helium II and the ordinary classical hydrodynamics of other liquids. In classical hydrodynamics the relationship between velocity, height and pressure at any point in a flowing liquid is given by Bernoulli's theorem as :—

$$\tfrac{1}{2}wv^2+wgh+p=\text{constant}$$

where w is the density of the liquid, v is its velocity, h is the height above a given reference point, and p is the pressure upon the liquid. A more general expression, applicable to the two-fluid counterflow of second sound in helium II, was developed on the basis of the two-fluid theory by Dr. Pellam shortly before the Rayleigh disc experiments were begun at the Bureau. It takes the form :—

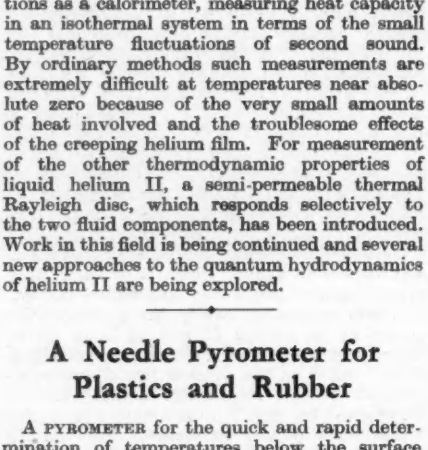
$$\tfrac{1}{2}wv^2+wgh+p+\tfrac{1}{2}\frac{w_n}{w_s}\frac{\dot{H}^2}{(w\dot{\phi}T)^2}=\text{constant}$$

where w_n and w_s are the densities of the normal fluid and superfluid, respectively, $\dot{H}$ is the rate of heat transfer, ϕ is the entropy, and T is the absolute temperature. Here the final additional term relates the hydrostatic pressure of the two fluids to the density of the heat current which constitutes second sound. The generalised Bernoulli expression has now been confirmed by measurements of the torque on the disc. Thus, for every classical experiment in hydrodynamics, there is likely to exist the quantum parallel in helium II where heat flow replaces mass flow. For example, recent experiments at the N.B.S. have shown that a pitot tube as well as a Rayleigh disc responds to the heat current in helium II. The thermal Rayleigh disc provides a means of investigating further the hydrodynamic flow of the normal and the superfluid. The precision of the Rayleigh disc apparatus in use at the bureau is such that it provides a new quantitative method for measuring many properties of liquid helium II. Some, like the intensity of second sound, had never before been measured. Even such thermodynamic properties of helium II as its specific heat at constant volume have been determined by the disc technique with greater accuracy than had previously been possible. The precision of measurement has, in fact, reached the point where the thermal Rayleigh disc functions as a calorimeter, measuring heat capacity in an isothermal system in terms of the small temperature fluctuations of second sound. By ordinary methods such measurements are extremely difficult at temperatures near absolute zero because of the very small amounts of heat involved and the troublesome effects of the creeping helium film. For measurement of the other thermodynamic properties of liquid helium II, a semi-permeable thermal Rayleigh disc, which responds selectively to the two fluid components, has been introduced. Work in this field is being continued and several new approaches to the quantum hydrodynamics of helium II are being explored.

A Needle Pyrometer for Plastics and Rubber

A PYROMETER for the quick and rapid determination of temperatures below the surface of plastic or semi-plastic materials has been developed by the Cambridge Instrument Company, Ltd., Cambridge.

As illustrated herewith, it consists essentially of a hollow stainless steel hypodermic needle, about 1in long, housing a sensitive thermocouple, which is connected by a short length of lead to an indicator. Our illustration shows the hand-held indicating instrument, but the thermocouple needle can be used equally well with the more conventional portable or wall mounting forms of indicator. The needle is mounted in an insulated handle and the connecting leads are protected by a flexible steel sheath. When the needle is not in use it can be covered by the metal cap shown in the illustration. The indicators are calibrated to give direct temperature readings, the normal range being 0 deg. to 200 deg. Cent. or 50 deg. to 400 deg. Fah.



NEEDLE PYROMETER

Useful applications for the needle pyrometer are to be found in various processes in rubber manufacture—from the breaking down of crude rubber before adding fillers, to the processes involving accelerators and fillers. Similarly the needle pyrometer can be used to indicate when the optimum temperature is reached in extrusion and in calendering.

In plastics manufacture the instrument is useful for checking temperatures in extrusion processes and in "preforms."

A Works Apprenticeship School

As a further step to secure the future of craftsmanship at its Westwood Works, Peterborough, Baker Perkins, Ltd., is to build a new trade school. Contracts for a new building have been placed and new machine tools and other equipment are on order.

This company has for more than a century regarded apprentice training as an important part of its organisation. In 1944 it had a separate training section for fitter and machinist apprentices and subsequently, as it became evident that special training arrangements for other trades would have to be made, completely equipped sections for this purpose were set up in the plate shop and the foundry. As part of its basic scheme the company initiated a planned pre-apprenticeship course for boys leaving school at the age of fifteen to provide short periods of introductory training in each of the principal production shops. Under this plan a boy receives short, practical experience of several crafts before he needs finally to make up his mind on the one he wishes to follow. There are now some 240 apprentices in Westwood Works and by July, 1954, it is expected that every apprentice in the factory will be serving under indentures.

It is intended that the new school shall supersede the three existing training workshops. Under the new scheme there will be provided, for the exclusive use of apprentices and trainees, a machine shop, tool room, fitting and erection shop, fabrication shop with welding bays and all attendant engineering services. The school will be completely equipped with the most up-to-date tools of the industry appropriate to training. Foundry training will, by technical necessity, continue to take place in the existing foundry training bays, but foundry apprentices will have the use of the new amenities of the school.

In order that apprentices shall not be completely segregated from the main works, it is intended that only the first year of their time will be spent in the school itself, particularly as the company believes that training sections, however modern, cannot fully replace the personal instruction which craftsmen themselves give to the apprentices when they work at their side in the main shops.

S. J. ELLIS MEMORIAL LECTURESHIP.—It is proposed to institute an annual lecture to the engineering students at Birmingham University to commemorate the work of the late Mr. S. J. Ellis, who was for thirty years lecturer in charge of the heat engines laboratory of the Department of Mechanical Engineering. Many former students have already contributed to the "S. J. Ellis Memorial Lectureship Fund," but should there be any who wish to do so they are invited to send donations to Mr. W. A. Linning, Department of Mechanical Engineering, The University, Edgbaston, Birmingham, 15.

A Rectifier Installation in an Insecticide Factory

We have received some interesting details of a pumpless mercury arc rectifier installation in the North Rand factory of Klipfontein Organic Products, South Africa. In this factory DDT and BHC (benzehexachloride) insecticides are manufactured by a process involving the liberation of chlorine by the electrolysis of brine. The direct current requirements for this electrolytic process are met by an installation of pumpless air-cooled, steel tank, mercury arc rectifiers.

The original equipment, which was supplied by the General Electric Company, Ltd., and went into service at the beginning of 1951, consists of three 660kW rectifier units, illustrated herewith, giving a combined d.c. output of 4500A at 440V. Each unit is arranged for grid control, a common requirement in equipments for electrolytic service where the plant may be called upon to operate for long periods at reduced voltage. These rectifiers are scheduled to operate, without interruption, for periods of three to six months. They are of the company's standard multi-anode design, of side-arm construction, embodying the "Vitric" seal for anode, grid and cathode insulation.

THREE 1500A 600kW GRID-CONTROLLED PUMPLESS RECTIFIERS

The three rectifier transformers, which are supplied through two 2500kVA transformers operating in parallel, are designed to provide the six-phase input to the rectifier cylinders. They the oil-immersed, indoor units, and are arranged along one wall of the converting station, which is a well-lit, spacious building. The rectifiers, which are installed in line down the centre of the station, are mounted in sheet steel cubicles arranged in three groups, each group consisting of a twin-cylinder rectifier cubicle and a grid control cubicle fitted with a handwheel control. Protection is provided by anode fuses and Salford line-contact d.c. circuit breakers on the output side, while the 2200V incoming supply is controlled by a three-panel switchboard of the company's "S.V.D." type, with circuit breakers rated at 100MVA.

While the a.c. supply is nominally at 2200V, it is subject to considerable variation and, at times, falls as low as 1950V. To deal with this variation, the rectifier transformers are arranged with $\pm 2\frac{1}{2}$ per cent and ± 5 per cent tappings on the high voltage side.

A special requirement was occasioned by the gradual replacement of existing electrolytic cells by new ones of the Hooker type. When supplying the existing cell lines, the procedure is to start operation at about 100V, and gradually to increase the voltage over a period of about ten hours to 332V, rising finally to 440V at full load, grid control being employed to ensure a smooth change of voltage. The new Hooker cells, however, operate at a much lower voltage than the original ones and, to overcome the disadvantage of operating at reduced voltage and consequent low power factor, the rectifier transformers are equipped with links for star-delta changeover of the primary windings. Thus the maximum d.c. voltage is reduced from 440V to the 235V required by the new cells. The supplies for the rectifier auxiliaries are taken from tertiary windings on the transformers and their voltage is, therefore, also reduced in proportion when the star-delta changeover is made. This difficulty has been overcome by the introduction of a 10kVA oil-immersed auto-transformer fitted with a three-pole switch, which is operated to maintain the correct auxiliary voltage for either star or delta connection of the transformer primary.

A further requirement of the installation is that the plant may be operated either as individual cell groups, each supplied by its own rectifier, or, alternatively, with all the cell groups connected in parallel to take a current of 4500A, in which case all three rectifiers will be connected to a common busbar. For operation under the latter conditions, it has been arranged that the phase-shifting transformers, which are wired for independent push-button motor control or for emergency handwheel control, may be connected in such a way that any one phase shifter can take over control of the three units in parallel, suitable interlocks being provided to prevent mal-operation. It is possible, of course, for the output voltage to be reduced to zero for either 440V or 235V working and with the units operating either singly or in parallel.

After this installation had been in commission for several months, it was decided to extend the plant up to the full capacity of the supply transformers by adding further lines of Hooker cells. An order was therefore placed with the G.E.C. for three more twin-cylinder rectifier equipments, similar in construction to the original plant but rated at 807kW. This addition will bring the total d.c. output of the station to about 10,000A. It is proposed to use the same methods of grid control as those employed on the existing equipment, but the correct parallel operation of the two complete groups will be achieved by the use of mechanically coupled master phase-shifting transformers.

The history of Klipfontein Organic Products is of some interest since the factory at North Rand was originally established for the production of war gases. Fortunately, they were never actually used and towards the end of the war the factory was converted to meet the urgent call for DDT to combat typhus among civilian refugees and troops in the European and Far Eastern theatres. On the cessation of hostilities, it was decided that, since DDT was proving to be a very valuable insecticide in a field much wider than had been envisaged for military purposes, the factory should continue in operation on a national basis, and it was accordingly handed over to the Department of Commerce and Industries under the Minister of Economic Development.

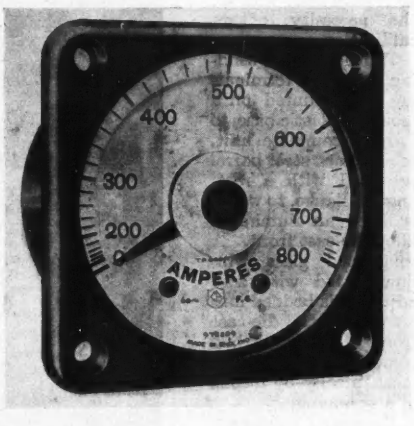
There were three early major peace-time demands on the output of DDT—first for the control of typhus, particularly in the Native territories, where powder is now distributed, free of charge, to the native population; secondly, for malaria control in the Northern Transvaal and Natal; and, thirdly, for insecticide to be sprayed from aircraft over the tsetse fly areas in Northern Zululand, where the results obtained have been very satisfactory, permitting the immediate stoppage of game slaughtering.

Equally important results have since been achieved in general agricultural applications. DDT dusts have proved particularly effective in the control of the maize stalk borer, which in seasons of heavy infestation, has been known to destroy maize with a potential crop value of over a million pounds. The sheep blow-fly has been found to be susceptible to DDT and to BHC, the cost of treating a sheep being only a fraction of a penny. As dipping agents for tick control these insecticides are beginning to replace the arsenical dips formerly used and there are indications that their use will eventually be the accepted practice among stock farmers, breeders and dairymen.

Circular Scale Switchboard Instruments

Switchboard moving-iron ammeters and voltmeters ("C.K.A." Pattern) with 4in. diameter dials and 6½in long, 240 deg. circular scales have been added to the range of instruments made by Crompton Parkinson, Ltd.

Although the moving-iron circular-scale instrument has been made in England for about forty years, the usual practice for a.c. measurements has been to employ a moving coil instrument with a rectifier or, alternatively, an induction instrument. Both the latter kinds are comparatively costly and Crompton Parkinson, Ltd., has developed this new design to meet the demand for a small compact long-scale instrument, available at a price that compares favourably with that of the short-scale instruments. This has been achieved by concentrating on production of only the popular 4in diameter dial, flush mounting pattern, which has the advantage of easy accommodation

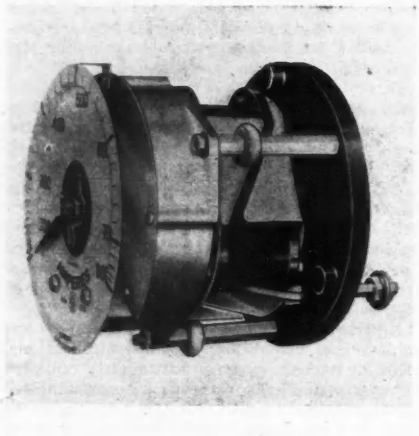


4IN DIAL AMMETER

on switchboards with adequate visibility for normal operations.

The square front of the instrument is only $4\frac{1}{16}$ in in width and the case is constructed so that it can be fixed from the front if required.

Normally the finish is bright black enamel. As illustrated herewith, the instruments are easy to read without parallax error, because the tapered-spear type pointer moves in the same plane as the scale marked on the raised rim of



AMMETER MOVEMENT

a platform dial. The instrument has a spring-controlled repulsion movement with the addition of attraction elements forming part of the magnetic screens. These screens provide magnetic shielding against interference from external magnetic fields and also increase the efficiency of the movement by reducing the ampere turns required in the winding to produce full-scale deflection.

The moving part of the assembly is mounted on hardened and polished carbon steel pivots working in synthetic sapphire jewel bearings which are spring mounted to protect the pivots from damage due to vibration and shock. Pneumatic damping is effected by a vane working in a dashpot which forms part of the die-cast tin-base alloy movement frame. The complete movement assembly forms an integral unit, which may be withdrawn from and replaced in the instrument without the necessity of re-calibration.

The movement, winding, dial and terminals are all mounted on a moulded plastic base to form a complete unit, in a pressed steel barrel provided with a rectangular flange, to which is fitted an aluminium alloy die-cast front. A toughened glass window, fitted with zero adjuster, is bedded into a recess in the die-cast front with a sealing compound and secured mechanically by means of a spring clip.

To ensure continued accuracy under severe service conditions the instruments have resilient mountings. A rubber gasket between the base of the steel barrel, and the moulded plastic base and rubber packing sealing the joint between the die-cast front and the flange of the steel barrel, make the instrument dust and dampproof. The main fixing screws are retained in position against continuous vibration by a brass locking ring.

Each instrument is individually calibrated and at marked frequency or range of frequency the error at any part of the scale within the effective range does not exceed 1 per cent of maximum scale value. The effective range extends from the maximum scale value down to 20 per cent of the maximum scale value. Stray field error is less than 1 per cent when tested in accordance with the provisions of B.S. 89.

Particulars of Movement

Weight of moving part assembly	2·5 grammes approx.
Torque for full-scale deflection	0·36 grammes/cm approx.
Damping when tested in accordance with B.S. 89	1·25 sec approx.
Ampere turns for full-scale deflection	240
Burden imposed by ammeter indicator winding at full-scale deflection on associated current transformer	1·25VA approx.

In the case of voltmeters the necessary resistances are mounted on the back of the instrument and protected by a moulded plastic cover. This precaution prevents fogging of the glass due to heating, but keeps the instrument self-contained.

The self-contained range is: minimum 0/30V, maximum 0/600V. For higher ranges an indicator is used with a voltage transformer. Its overload capacity is $1\frac{1}{2}$ times maximum scale value continuously; the temperature coefficient is less than 0·1 per cent per deg. Cent.; the self-heating error is less than 1 per cent.

With the ammeters the self-contained range is minimum 0/1A, maximum 0/20A. For higher ranges an indicator is used with a current transformer. The overload capacity is 1000 per cent momentarily, 200 per cent for fifteen minutes, 150 per cent continuously. The temperature coefficient is less than 0·05 per cent per deg. Cent.; the self-heating error is negligible.

FUEL DISTRIBUTOR

A Fuel Distributor

A FUEL distributor for use with chain grate stokers of water-tube boilers has recently been introduced into this country by the Reiss Engineering Company, Ltd., Stanmore, Middlesex, and the accompanying photograph shows a double distributor which is installed at a colliery. In the distributor illustrated, two qualities of fuel are used, namely, coke breeze and coal, which are sandwiched on the chain grate. The front distributor receives the coal via a round chute and the back distributor by a conveyor belt discharging into a hopper.

The distributor consists of a slowly travelling carriage, which spreads the coal evenly over the grate hopper and so ensures even mixing, thus giving even burning, high carbon dioxide and low ash loss. This method obviates the disadvantages of the usual form of chute, in which the fuel segregates in size, the fine particles collecting in the centre and the larger fuel flowing to the sides. Thus the forced air penetrates the fuel bed at the sides and gives rise to intense combustion, while in the central area the packed fine fuel resists the passage of the air so that unburnt fuel passes over the fire bridge and the irregular combustion results in a low carbon dioxide and a high carbon monoxide content. In addition to the foregoing disadvantages there are mechanical troubles through undue wear of the stoker elements due to uneven combustion.

A rectangular steel frame, open at the top and bottom, and divided into a number of compartments by vertical walls, forms the distributor. In general terms, the length of the frame is half the width of the receiving hopper plus slightly more than half the width of the coal chute, while the width is governed by the width of the hopper, but is about 20in to 24in. The hourly fuel consumption determines the height of the frame. Two channel sections built on to the hopper form a low track along which the frame, which is carried on small wheels, is moved slowly from side to side.

The coal chutes are in line with the centre of the hopper so that one compartment of the distributor is always below it and each compartment is filled with a mixture of coarse and fine coal. The coal in the hopper is level with the lower edge of the frame so that the fuel in the compartment cannot fall and is carried to right or left, and it can only slide down when the coal in the hopper sinks by dropping on to the grate. Large coal is prevented from rolling towards the outer edges and fine particles cannot be concentrated in the middle.

A geared motor moves the distributor frame backwards and forwards by means of a chain drive and at each end of the travel is a flap, which operates a reversing switch which changes the direction of movement. When there is sufficient coal in the hopper a pendulum switch halts the frame, at one end or the other of its travel, for a period of time sufficient to allow the level of coal to fall and then automatically restarts the motor. The power required for the operation of the distributor is low, motors of $1\frac{1}{2}$ h.p. to 3 h.p. being fitted and these have an adequate margin of power. Hand operating gear is provided to guard against any electrical failure.

CEMENT IMPORTS.—The Minister of Works has been in consultation with the Cement Makers' Federation about the supply of cement in Scotland and on the North-East Coast, where there have been exceptional demands during the first few months of this year, for defence and other purposes, much in excess of the corresponding period of last year. The shortage has to some extent been mitigated by imports from the Continent, but, having regard to the fact that payments for imports from Europe are now, in effect, almost all in gold or dollars, it has been decided that no further imports shall be authorised. The Cement Makers' Federation has co-operated fully and its members are taking steps to increase the supply of British cement despatched to Scotland and the North-East Coast. Deliveries of cement from the works, it is stated, are now at record levels.

Industrial and Labour Notes

The Economic Situation in Europe

A review of the economic situation in Europe in the final quarter of 1951 and the early months of the present year has just been published by the United Nations Economic Commission for Europe. It says that, although the overall volume of exports of fifteen Western European countries averaged about 15 per cent more in 1951 than in the preceding year, and almost 50 per cent more than in 1949, there was no general rise following the spectacular increases achieved in the third and especially the fourth quarters of 1950. According to the review, a temporary limit had been reached by the end of 1951 to the expansion of European exports, although they were still at a relatively high level. For engineering exports, it is stated, the demand is likely to be strengthened by the growing dollar shortage in a number of overseas areas, but it is pointed out that a further increase depends on a more abundant supply of metals. The review notes that order books in the engineering industry are still full and that in some branches delivery periods are lengthening.

Dealing with output, the review says that production in most Western European countries—which normally reaches a seasonal peak in the last quarter of the year—fell short of previous peaks in the last quarter of 1951. The decline was clearly marked in Norway, Denmark, Finland, the Netherlands and the United Kingdom, and was also apparent in two countries—Belgium and Italy—which did not have full employment. The main reason given for the falling off in total industrial output was the continuing slump in the textile and clothing industries and in other branches producing durable consumer goods. The review goes on to explain that a smaller demand affected consumer goods made by the engineering industries, especially in the smaller countries, it being remarked also that in the major producing countries output was held back by metal shortages and by dislocations caused by conversion to armament production. Another comment made in the review is that the easing of the European "short-term coal shortage," as a result partly of the mild weather, partly of higher coal production and partly of the slowing-down of industrial expansion, "contributed to an atmosphere acting against speculative stockbuilding." From there, the review goes on to state that the steel shortage is far from ended, although it is expected that the expansion in steel capacity in the U.S.A. will lead to a reduced American demand for iron and steel, with consequent easing in the European market.

Lead and Zinc Prices

The Ministry of Materials has announced reductions in the prices of lead and zinc, both of which became effective from May 22nd. The price of imported good soft pig lead has gone down by £2 and is now £129 a ton delivered consumers' works. The price of zinc has been reduced by £24 a ton, good ordinary brand zinc now being £166, delivered consumers' works. Premiums for the higher grades remain unchanged.

Britain's Overseas Trade

The Board of Trade has now issued some particulars of the United Kingdom's export and import trade in the month of April. The final figures show that exports were valued at £217,500,000, a figure which was 8 per cent below the monthly average in the first quarter of this year. Two factors which influenced the April export figures were that, owing to the Easter holiday, there were only twenty-four working days, compared with the normal twenty-six, and also that restrictions on imports introduced by some Commonwealth countries began to show their effects. United Kingdom exports to Australia, for example, reached a total of only about £18,500,000 in April, compared with a monthly average of £34,400,000 in the first quarter of the year and £27,000,000 in 1951.

Exports of metals and engineering products during April reached a value of £115,100,000, which was £4,900,000 below the average for the first quarter of this year. The daily rate of export, however, was 4 per cent higher. Most of the decrease in value in this group in April was accounted for by lower exports of cars and commercial vehicles. The Board of Trade says that the reduction was no more than was to be expected when allowance is made for the Easter holiday. Exports of non-ferrous metals in April were valued at £6,300,000 a figure which was below the rather high level of the first quarter; but there was an increase in the exports of iron and steel, the value of which amounted in the month to £16,400,000. Machinery exports in April were valued at £37,200,000, which was about £400,000 below the first quarter's average. If allowance is again made for the shorter working month, the rate of export of machinery may be taken to have risen by about 7 per cent. Exports of internal combustion engines, valued at £2,800,000, were considerably higher in quantity and in value than the average for the first quarter, and electrical machinery exports, at £5,600,000, also exceeded the first quarter's level. There were, however, small decreases in exports of agricultural machinery and machine tools.

The total value of imports in April was £325,500,000, which was £2,700,000 lower than the first quarter average, and much the same as the monthly average over the whole of last year. Re-exports in April were valued at £11,600,000, which marked a considerable drop from the particularly high first-quarter average of £18,300,000. The Board of Trade says that although, during April, the total value of imports of raw materials was almost the same as during the first quarter, the composition showed some changes. The main decreases were in imports of timber and paper-making materials. Furthermore, because of price reductions, rubber imports in April, although much the same in quantity as in the first quarter, were 11 per cent lower in value. Imports of iron and steel continued the upward trend of the first quarter and arrivals of non-ferrous metals and manufactures thereof were above the high average of the first quarter. Machinery imports also continued throughout April at the high level of the first quarter.

Wages and Economic Requirements

Addressing the annual meeting of the Union Bank of Scotland last week, the chairman, Lord Bilsland, made reference to many of this country's present economic requirements. He said that "invisible earnings" were unlikely to rise this year above the low level of 1951, and it was therefore essential that every effort should be made to maintain our export trade and, where possible, increase it. Apart from the necessity of re-establishing its reserves at an adequate level, it was essential for this country to earn a surplus to enable it to participate in the development and progress of the Commonwealth and to protect its overseas trade.

The restoration of a surplus in our balance of payments, Lord Bilsland continued, was a gigantic task, beset with many difficulties. In the first place, it was vital that inflation be held in check, and it was impossible therefore not to regard without serious concern the many claims for increased wages announced in recent months. Unless increased wages were linked with higher productivity, Lord Bilsland added, they inevitably resulted in higher costs, with a serious effect on export trade, and in a reduction in the standard of living of others and ultimately of all. To buy half the food this country required and much of the raw materials of industry, it must sell overseas what its customers would buy at prices they were willing to pay—or go hungry and suffer severe unemployment. That, Lord Bilsland observed, was a reality from which we could not escape. He went on to suggest that the fact that the duty of facing economic reality appeared so often to be evaded for political expediency was a disquieting feature of modern democracy. Clearly, Lord Bilsland said, we were not earning the means to provide a higher standard, as the *Economic Survey for* 1952 showed that output per man in 1951 was only 1 per cent greater than in the previous year. He hoped that the British Productivity Council, which was shortly to be established, would receive the full support of management and organised labour.

The Approach to Wage Problems

The annual conference of the Electrical Trades Union is being held at Eastbourne this week, and in his presidential address, delivered last Monday, Mr. Frank Foulkes urged that there should be a new approach to wage problems and opposition to any wage freeze. He said that to win increases which offset the rapidly rising costs of living was a major problem, and that if industrial strife was to be avoided speedier negotiation and quicker decisions were necessary. "The trade unions," Mr. Foulkes declared, "should fight with all their industrial might against any attempt by any political party to introduce a wage freeze. The requirements of the workers within an industry and the skill displayed by them should be the deciding factors in wage assessment."

Industry in Northern Ireland

The Northern Ireland Ministry of Commerce has produced an illustrated booklet entitled *Blueprint for Industry*, which records recent industrial development and explains the facilities available to firms which wish to establish factories in Northern Ireland. The booklet points out that the Ministry of Commerce has power to provide factory premises and to lease them to industrial concerns capable of creating long-term and continuing employment. The standard factory buildings normally provided by the Ministry are described, and it is stated that leases are normally granted for terms of fifteen to twenty-one years, with an option to the tenants for renewal. On the other hand, industrialists who prefer to build their own factories are offered assistance in the provision of sites and advised as to the most suitable locations. Copies of the booklet can be obtained from the London office of the Government of Northern Ireland, 13, Regent Street, W.1.

Coal Production

The total output of coal in Great Britain last week was 4,609,700 tons, of which 4,331,200 tons came from the deep mines and 278,500 tons from opencast workings. Production in the first twenty-one completed weeks of this year, ended last Saturday, has amounted to 93,205,900 tons, compared with 91,347,800 tons in the corresponding period of 1951. Coal imports this year have totalled 318,000 tons.

The coalmining manpower situation continues to improve, the number of wage earners on colliery books on May 17th being 716,300, of whom 291,900 were working at the face. A year ago the number of wage earners on the books was 702,600, of whom 288,600 were face workers. The number of shifts worked per wage earner in the week ended May 17th was 4·99, the output per manshift at the face being 3·14 tons. Voluntary absenteeism in the same week was 4·58 per cent.

Inland coal consumption in the first twenty weeks of this year amounted to 85,377,000 tons, or nearly 1,000,000 tons less than in the comparable period of last year. In the same weeks, however, a greater amount was taken up by exports and bunkers, this year's total being 5,151,000 tons, compared with 3,628,000 tons last year. Distributed stocks of coal on May 17th amounted to 14,126,000 tons. A year earlier they were 10,090,000 tons.

Notes and Memoranda

Rail and Road

CLOSING OF HAMMERSMITH BRIDGE.—Hammersmith bridge is to be closed to vehicular traffic this summer from some date in July or August for essential repairs. Owing to the serious inconvenience which this measure will cause, the work will be carried out as quickly as possible and will, it is estimated, take two or three months to complete. It was thought that the complete redecking could be completed with the least inconvenience by closing the bridge for this period, rather than allowing single-line traffic over a longer period.

ROAD DEVELOPMENT IN THE CAMEROONS.—A report recently presented to the General Assembly of the United Nations says that the development of the Cameroons outside the plantation lands leased to the Cameroons Development Corporation depends on road improvement, work on which has already begun. The work includes the improvement of the Victoria-Bamenda road, the construction of a road connecting the Benue Province and Bamenda Province systems, and the improvement of the roads from Maiduguri to Bama and southwards to effect a link between the southern and northern halves of the territory.

ROAD BRIDGE AT MARGATE.—A ninety-year-old steel bridge over the main London-Ramsgate railway line has recently been replaced by a new bridge composed of precast concrete members. The two main parapet girders span 62ft 4in on a skew of 32 deg. and rest on brick abutments 27ft 9in apart; they are 6ft deep at one end, 7ft at the other and weigh approximately 31 tons each. The deck beams vary in size according to their position, the largest being 30ft 9in by 3ft 6in by 1ft 7½in. They are hollow, having twin precast concrete tubes with O.G. joints, down the centre. The bridge was slung into position by British Railways, Southern Region, during the nights of March 15th-18th.

Air and Water

AERONAUTICAL RESEARCH FELLOWSHIP.—The English Electric Company, Ltd., announces that it has established a new research fellowship valued at £500 a year, at the College of Aeronautics, Cranfield. The purpose of the fellowship is to promote the study of advanced problems involved in aeronautical engineering. Holders of the fellowship will be mainly concerned with investigation into problems of vibration, stability and the control of aircraft, all of which are of particular interest in view of the high speeds of flight now being reached.

ENGINEER OFFICERS FOR MERCHANT NAVY.—The progress of the scheme for the training of engineer officers for the merchant navy, which was announced in February, has been reviewed by the Ministry of Transport with the shipping companies. The Ministry of Education and the Scottish Education Department have conferred with local education authorities with a view to the establishment at suitable technical colleges of the two-yearly ordinary national diploma courses, and final decisions will be made at the end of June.

Miscellanea

OBITUARY.—We have learned with regret of the death of Mr. Alfred Beebee, which occurred on May 19th. Mr. Beebee, who was in his eightieth year, was the senior director and founder of the firm of Alfred Beebee, Ltd., Wood Street Works, Wednesbury.

CORRECTION.—In the article describing the Kent Oil Refinery which appeared in our issue of May 16th last, part of the civil engineering work was attributed in error to George Wimpey and Co., Ltd. We are informed that the company is the main mechanical engineering contractor.

STANLOW REFINERY.—We have received from Whessoe, Ltd., of Darlington, an illustrated brochure which contains photographs and short descriptions of the work carried out by the company at the Stanlow Refinery, including the catalytic cracking plant, large columns of the distillation unit, and many other items of equipment.

B.R.L. SLIDE RULES.—We recently examined a 10in "B.R.L." slide rule made by Blundell Rules, Ltd., Luton, Beds. It is made entirely of a material based on vinyl chloride—vinylidene chloride copolymers, usually referred to as P.V.C. copolymers. This material is stated to be highly resistant to water absorption and to have constant linear dimensions independent of climate. It is white, with a "semi-matt" finish, which is capable of carrying fine engraving.

CONFERENCE ON FLUIDISATION TECHNOLOGY.—A conference on "Fluidisation Technology" is being arranged by the chemical engineering groups of the Society of Chemical Industry, the Koninklijk Institut van Ingenieurs, and the Netherlands Chemical Society. It will be held in London on June 12th and 13th at the Connaught Rooms, Great Queen Street, Kingsway, W.C.2. On the day following the conference—Saturday, June 14th—delegates are to visit the Fawley refinery of the Esso Petroleum Company, Ltd. The detailed programme of the conference is available from the Society of Chemical Industry, 56, Victoria Street, London, S.W.1.

CONCRETE SHELL ROOF CONSTRUCTION.—A symposium on Concrete Shell Roof Construction, organised by the Cement and Concrete Association, is to be held on July 2, 3 and 4, 1952. The first day's papers will deal with the architectural aspect of concrete shell roofs and will be given at the Royal Institute of British Architects. The second and third days of the symposium will be held at the Institution of Civil Engineers and will be devoted to design and research and construction respectively. Five papers will be presented on the second day and four on the third. Application for membership of the symposium, which is free, should be made to the organising secretary, Symposium on Concrete Shell Roof Construction, Cement and Concrete Association, 52, Grosvenor Gardens, London, S.W.1.

THE SCIENTIFIC EDUCATION OF PHYSICISTS.—The Institute of Physics has published a new report, *The Scientific Education of Physicists*, to give authoritative guidance to schoolboys and girls who contemplate physics as a career. The report includes factual information about the physics departments of all the universities and university colleges of Great Britain and Northern Ireland and to those technical colleges which are recognised by the Institute of Physics. The nature of the honours course in physics in each university is indicated together with the approximate number of students admitted each year; the main branches of physical research now in progress are also given. Copies of the report are obtainable from the Institute of Physics, 47, Belgrave Square, London, S.W.1, price 2s. post free.

AGRICULTURAL MACHINERY DEMONSTRATION.—We were invited to witness recently, at Enfield, an extensive field demonstration of agricultural implements, contractors' plant and other equipment, designed for working with the "New Fordson Major" tractor. The demonstration was organised by Ford Motor Company, Ltd., Dagenham, Essex, which introduced the tractor last November. The tractor, which was described in THE ENGINEER of November 30, 1951, offers a choice of three Fordson four-cylinder engines—petrol, vaporising oil or diesel—and at an engine speed of 1600 r.p.m., develops about 29 d.h.p. At the demonstration, two interesting conversions of the "New Fordson Major" were to be seen. They were a narrow-gauge conversion and an orchard conversion, which are being introduced to suit working conditions in hop gardens, vineyards and orchards.

SCHOOL OF GAS TURBINE TECHNOLOGY.—Power Jets (Research and Development), Ltd., has issued a programme of courses to be held during the remainder of this year at the School of Gas Turbine Technology, Farnborough Place, Farnborough, Hants. The design courses are of approximately post-graduate standard and are open to students of British or Commonwealth nationality. They include the running of engines together with performance calculations. The Industrial Design Courses also include specialist lectures on economics and on the use of gas turbines for power generation, ship propulsion, land traction and process plant installations. The Practical Aero Courses are open to students of any nationality. These courses are concerned principally with stripping and assembly work, and do not require a high standard of academic knowledge. The programme is as follows: Course number 49, Practical Aero-Engine Course, two weeks, June 9th to 20th; 50, Theory and Design of Compressors, one week, June 30th to July 4th; 51, Combustion and Heat Exchangers, one week, July 7th to 11th; 52, Theory and Design of Turbines, one week, July 14th to 18th; 53, Aero-Engine Design, three weeks, August 11th to 29th; 54, for overseas students only; 55, Practical Aero-Engine Course, two weeks, October 6th to 17th; 56, Design and Applications of Industrial Gas Turbines, three weeks, October 27th to November 14th; 57, Aero-Engine Design, three weeks, November 24th to December 12th.

SAND AND GRAVEL IN UPPER THAMES AND LOWER SEVERN.—Allocation of land for sand and gravel working to maintain supplies at a reasonable cost in the Middle and Upper Thames and Lower Severn Valleys over the next fifty years is the subject of a report of the Advisory Committee on Sand and Gravel, which has now been published by H.M. Stationery Office. In the Middle and Upper Thames region demand for sand and gravel is estimated at 1·75 million cubic yards a year for the next fifty years, but the committee has recommended that this estimate should be reviewed at five-yearly intervals. Generally throughout this region the gravel-bearing land is not of the highest agricultural quality, and the main conflict with agricultural and amenity occurs near Marlow and south of Maidenhead. In these areas the committee has severely restricted its allocations. In the Lower Severn region future demand is estimated at 500,000 cubic yards a year. The committee has again recommended that the estimate should be reviewed regularly. Reserves in this region are so limited that it is unlikely that pits will be able to maintain production at the estimated level for fifty years, and the committee has pointed out that future supplies will have to be maintained by an increase in the import of gravel from neighbouring regions. The gravel-bearing areas in this region give rise to land of extremely high agricultural quality, but, although the allocations have been strictly limited, the committee has not recommended the complete cessation of gravel working on all good quality farmland because of the serious disruption of supplies and the sharp increase in the price of gravel which would result.

Personal and Business

THE HAWKER SIDDELEY GROUP announces that Mr. H. G. Herrington has been appointed managing director of High Duty Alloys, Ltd., Slough, Bucks.

EASTWOODS, Ltd., announces that Lieut-Colonel Sir Thomas Moore has been appointed a director. Mr. B. H. Marriage has been appointed sales director.

THE ENGLISH ELECTRIC COMPANY, Ltd., states that the London section of its publicity department is now at Marconi House, 336–337, Strand, W.C.2 (telephone, Temple Bar 1577).

MR. NIELS MATHESON has relinquished his appointment as technical director of British Oilfield Equipment Company, Ltd., to devote full attention to his directorship of Associated Tube Wells, Ltd.

VACUUM OIL COMPANY, Ltd., announces the formation of a new and enlarged technical department, which is to be managed by Dr. R. B. Killingsworth, of Socony-Vacuum Oil Company, Inc., New York.

MR. CHRISTOPHER DYKES, M.A., M.Sc., formerly chief engineer (development) of B.O.A.C., has now started a practice as an advising aeronautical engineer at 31, Pembroke Gardens, London, W.8 (telephone: Western 9493).

LONDON TRANSPORT announces the following appointments in the department of the chief mechanical engineer (railways): Mr. J. G. Bruce, A.M.I.E.E., A.M.I.Loco.E., acting assistant mechanical engineer (works), and Mr. G. Clark, production engineer (Acton works).

NORTHEY ROTARY COMPRESSORS, Ltd., Parkstone, Dorset, states that Mr. P. E. Thomas, A.M.I.Mech.E., 33, Great Queen Street, London, W.C.2 (telephone, Holborn 4497), has been appointed technical representative for London and S.E. England in succession to Serco, Ltd.

MR. CHARLES RAMSDEN has retired from his position as overseas director of the Federation of British Industries, after thirty-three years' service with that organisation. His successor is Mr. Peter Tennant, who has been deputy overseas director of the F.B.I. for the past year.

LORD CUNLIFFE has resigned as chairman and a director of the National Gas and Oil Engine Company, Ltd., and has been appointed a director of The Brush Electrical Engineering Company, Ltd. Mr. A. E. Carrodus has also resigned from the board of The National Gas and Oil Engine Company, Ltd., and Mr. Miles Beevor has been appointed to it.

Mr. WALTER SYMES has resigned from the board of Metropolitan-Vickers Electrical Company, Ltd., and from the position of works manager at the Trafford Park Works, in order to become manufacturing consultant of Associated Electrical Industries, Ltd. Mr. Arthur C. Main, M.I.E.E., has been appointed works manager at Trafford Park and has been elected a director of Metropolitan-Vickers Electrical Company, Ltd.

British Patent Specifications

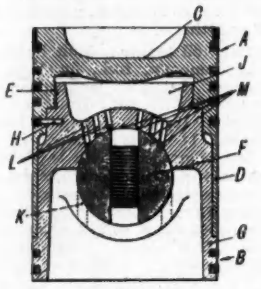
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

INTERNAL COMBUSTION ENGINES

670,525. July 11, 1949.—Pistons, Roland Laraque, 17, rue Marbeuf, Paris, France.

Referring to the drawing, it will be seen that the piston consists of two parts, *A* and *B*. The upper part comprises the head *C*, which forms part of the combustion chamber, and the greater part of the skirt *D*. It also contains a threaded part *E* into which is screwed the head of the lower part *B*. This



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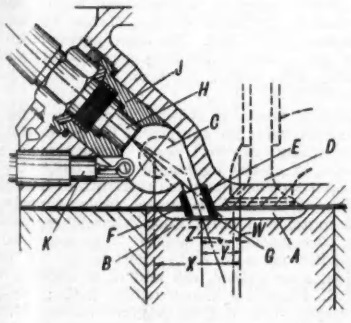
part is bored to receive the gudgeon pin *F*, for which it forms a complete upper bearing pin. The part *B* has a downward extension *G* which completes the skirt of the piston. The upper part of the piston bears on the lower part on two regions located on either side of the gudgeon pin. In order to prevent the two parts of the piston from becoming unscrewed while the engine is running, there is provided a cotter pin *H* which engages in the two parts. A chamber *J* remains between the two parts and serves the purpose of cooling the piston head by oil. The oil which is supplied to the bearing of the pin is recovered by the return passages *K* leading to the cavities between the ends of the gudgeon pin and the skirt of the piston. Other passages *L* provided in the upper bearing communicate with longitudinal lubricating grooves *M* on the bearing portion. As shown, the piston is provided with a flame guard and with a number of sealing rings and scraper rings.—*April* 23, 1952.

670,674. September 30, 1949.—Pre-Combustion Chambers, Daimler-Benz Aktiengesellschaft, Stuttgart, Unterturkheim, Germany.

In the drawing the engine comprises a main combustion space *A* formed by an eccentric depression in the head of the piston *B*. A spherical or cylindrical pre-combustion chamber *C*, arranged in the water-cooled cylinder head to one side with an eccentricity *X*, is adjacent to the inlet and exhaust valves *D*. The chamber is in communication with



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the main combustion space by way of a flow passage *E* fitted with a tubular insertion *F*, the mouth of which projects so far into the space *A* that when the piston is at the top of its stroke, as shown, a narrow annular gap *G* is formed between the mouth and the bottom of the depression. The mouth has an eccentricity *Y* as regards the cylinder axis and an eccentricity *Z* as regards the centre of the space; value of *Z* may correspond approximately to 0·3–0·4 of the radius of the space. The inclination of the passage *E* to the cylinder axis is about 20 deg. With this eccentricity and inclination of the passage good distribution of the outflow from the chamber is obtained. Favourable space conditions are created in the cylinder head for accommodating valves and cooling spaces and rotary motion is imparted to the air entering chamber *C* on the compression stroke. The injection nozzle *H* is inserted and supported by a sleeve *J* in a bore in the cylinder head, the axis of this bore passing through the centre of the chamber, and being inclined at an angle about 40 deg. to the cylinder axis. An incandescent ignition plug *K* is also shown.—*April* 23, 1952.

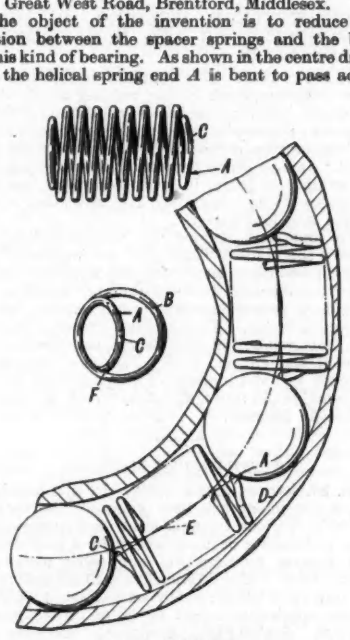
671,606. May 5, 1950.—Piston for Internal Combustion Engines, Maschinenfabrik Augsburg-Nurnberg A.G., (13b), Stadtbachstrasse, 7, Augsburg 2, Germany.

When pistons of internal combustion engines are under fairly high load they are sometimes damaged at the end facing the combustion chamber because of the high temperatures set up. According to the invention, there is provided a piston formed entirely or partially of a mixture of sintered metal and ceramic powder, the ceramic powder having high thermal insulating and heat-resisting characteristics and being substantially insensitive to temperature change. Preferably, the proportion of pure ceramic powder in the mixture on the upper side of the piston will gradually change until it becomes pure metal powder at a certain distance from the combustion chamber. The variation in this mixing ratio may be constant. It is thus possible to unite the upper part of the piston by welding or sintering to a lower piston part, consisting of pure metal, without any differing heat expansions acting in opposition at the surface of separation. A piston according to the invention has the advantage of good heat insulation without the disadvantages of direct cooling.—*May* 7, 1952.

MISCELLANEOUS

670,537. August 11, 1949.—Ball Bearings, Ronald William Mason, 16, Northumberland Gardens, Syon Lane, Isleworth, Middlesex, and The Sperry Gyroscope Company, Ltd., of Great West Road, Brentford, Middlesex.

The object of the invention is to reduce the friction between the spacer springs and the balls in this kind of bearing. As shown in the centre drawing, the helical spring end *A* is bent to pass across



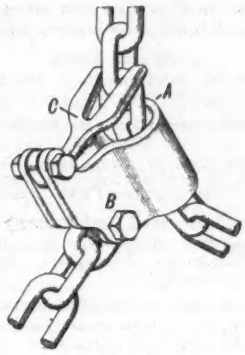
No. 670,537

the plane of the end convolution *B* in an arc that is bowed outwards at *C*. The springs are of such length and diameter that they fit loosely into the race *D* in compression between the balls, and the bowed arcs at their ends make contact with the balls at points substantially on the longitudinal axis *E* of the spring. The area of contact between each spring and its associated ball is only that of the end *C*, which is very much smaller than the whole end turn as in the prior arrangements so that the friction is considerably reduced. Preferably the tips *F* of the spring ends are smoothed by grinding.—*April* 23, 1952.

CRANES AND LIFTING APPLIANCES

671,413. July 19, 1949.—Slings for Bundles, American Chain and Cable Co., Inc., 230, Park Avenue, New York, United States of America.

The object of the invention is to provide a chain bundling device with reliable and positive means to enable the size of noose to be readily enlarged whilst enabling the noose to tighten itself about the load without risk of the load coming adrift.. The material to be lifted is encircled by a chain, on one end of which is a collar *A*, through which the chain readily passes and automatically tightens a noose formed around the material. The collar is in the form of a strap bent to form outstanding lugs *B* pierced by holes for receiving bolts or other



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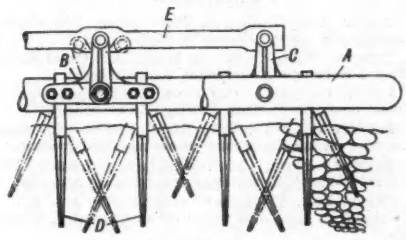
fastenings. The bolt on the lower part of the strap secures the strap and chain together. Pivoted to the strap by the upper bolt is a locking device in the form of a bifurcated plate *C*, which can rest upon the upper surface of the strap. The vee-shaped slot in the strap is so proportioned that a link can readily enter it, whilst the next link engages the upper side of the plate and the chain is held from further downward movement when the plate meets the upper surface of the strap. To release the locking device, it is necessary to lift on the chain until its slight upward movement is sufficient to permit the plate to be swung back away from the chain. This entails no danger to the men handling the device as the material being handled is still held in a compact bundle by the chain under tension. When the chain is lowered it may be released from the bundle.—*May* 7, 1952.

AGRICULTURAL MACHINERY

671,908. September 12, 1950.—Power Harrows with Swinging Prongs, Erich Röhr, trading as Maschinenfabrik Erich Röhr, Industriegelände, Landshut, Bavaria, Germany.

The drawing shows a harrow incorporating the invention. The frame *A* consists of a tube and between the two parallel sides of the frame there is only one row of tines. Three-armed cranks *B* pivot between the sides of the frame. These cranks have a central arm *C* and two side arms, each at 90 deg. On each of the arms a harrow tine *D* is secured by a "U"-shaped clamp and



No. 671,908

nuts. By this releasable fastening the length of the prongs can be altered according to the ground and the desired depth of operation and the tines can be easily replaced. The arm *C* is in two parts fastened to a boss, which is journalled on a pin. Both ends of the pin are secured in lengths of tube which pass through the frame and are fixed to it. The rod *E*, which connects all the cranks together, is connected to the motor by a coupling rod. The harrow can be arranged beside a tractor and pivotally connected with the same drive as is used for a mower bar, the motor being connected to the rod *E* by a coupling rod, which when a mower is used is connected to the cutter. The harrow can also be pulled behind a tractor and the reciprocation of the rod brought about by a bevel wheel driven from the motor and driving a crank. Since the tines are secured to pivoted cranks they move in a part-circular path, and the points of the tines travel a somewhat longer distance and at greater speed than the upper parts of the tines. Thus in the neighbourhood of the points of the tines the ground is more finely broken than higher up. The movement of the tines sideways and upwards produces slight ridges of earth between the tines so that the surface is slightly ridged.—*May* 14, 1952.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Chemical Society

Thurs., June 5th.—Burlington House, Piccadilly, London, W.1, reading of original papers, 7.30 p.m.

Conference Internationale Des Grands Reseaux Electriques

Wed., May 28th. to Sat., June 7th.—Fondation Berthelot, 28, Rue Saint Dominique, Paris, fourteenth meeting of the International High Tension Conference.

Incorporated Plant Engineers

To-day, May 30th.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham, "Refrigeration," A. C. Curgenven, 7.30 p.m.

Institute of British Foundrymen

Tues. to Fri., June 10th to 13th.—Buxton and Sheffield, forty-ninth annual conference.

Institute of Industrial Administration

Wed., June 4th.—LONDON CENTRE: Fyvie Hall, The Polytechnic, Regent Street, W.1, "The Human Factor—The Vitality of Management," "Forging the Manpower Link," R. R. Hopkins, 6.30 p.m.

Institution of Engineering Draughtsmen and Designers

Wed., June 4th.—Waldorf Hotel, Aldwych, London, W.C.2, Technical Executive Conference, discussion on "Can Engineering Design be Taught?" 7.30 p.m.

Institution of Production Engineers

Fri., June 13th.—EASTERN COUNTIES SECTION: Garrett Memorial Hall, Ipswich, "Oil for Britain," exhibition by Esso Petroleum Company; "Machine Lubrication," C. J. Taylor, 7.30 p.m.

Royal Society

Thurs., June 12th.—The University, Cambridge, "The Origin of the Solar System," H. Jeffreys.

Society of Chemical Industry

Thurs. and Fri., June 12th and 13th.—Connaught Rooms, Queen Street, Kingsway, London, W.C.2, conference on fluidisation technology.

Stephenson Locomotive Society

Sat., June 7th.—Afternoon visits to Brighton locomotive works, Brighton and Redhill running sheds.

West of Scotland Iron and Steel Institute

Fri., June 13th.—39, Elmbank Crescent, Glasgow, joint meeting with the British Iron and Steel Research Association, conference on all-basic furnaces, 10 a.m.

Catalogues

BIRLEC, Ltd., Erdington, Birmingham, 24.—Folder dealing with gas and electric furnaces.

HERBERT WIDDOWSON AND SONS, Ltd., Canal Street Works, Nottingham.—Machine tool catalogue.

JOSEPH CROSFIELD AND SONS, Ltd., Warrington.—Folder dealing with floor cleaning and treatment.

PLESSEY COMPANY, Ltd., Ilford, Essex.—Illustrated brochure on television components and loud-speakers.

HOLMAN BROS., Ltd., Camborne.—Leaflet No. PT/2100/52, dealing with pneumatic scaling hammers.

CRANE, Ltd., 45–51, Leman Street, London, E.1.—Folder giving details of valves for steam, water, oil and air.

ENGLISH ELECTRIC COMPANY, Ltd., Switchgear Department, Stafford.—Catalogue of air compressor equipments.

COVENTRY VICTOR MOTOR COMPANY, Ltd., Cox Street, Coventry.—Illustrated folder on marine diesel engines.

KEITH BLACKMAN, Ltd., Mill Mead Road, Tottenham, London, N.17.—Booklet describing the range of "Extravent" fans.

W. G. PYE AND CO., Ltd., Granta Works, Newmarket Road, Cambridge.—Catalogue of scientific instruments.

G. E. SIMM ENGINEERING, Ltd., East Parade, Sheffield, 1.—Leaflet describing the "Tirfor" machine for pulling and lifting.

THOMAS DE LA RUE AND CO., Ltd., Imperial House, 84/86, Regent Street, London, W.1.—Brochure on plastic extrusions.

SOLWAY FLOWRATORS, Ltd., Abbey Road, Park Royal, London, N.W.10.—Catalogue No. 51M., of variable area flow meters.

RAWLPLUG COMPANY, Ltd., Rawlplug House, Cromwell Road, London, S.W.7.—Fixing Devices brochure, twenty-second edition.

AUSTIC-LAYTON MACHINE TOOL COMPANY, Norwich.—Folder giving details of the "Taperturn" Model C.1. box tool for capstan lathes.

THE STANDARD AND POCHIN BROS., Ltd., Evington Valley Road, Leicester.—Publication No. 175, illustrating a range of small fans.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 24, Victoria Street, London, S.W.1.

ONE PER CENT CHROMIUM STEEL

No. S.115 : 1952. This standard applies to wires only for the manufacture of cold forged aircraft bolts of ¼in shank diameter and over. Price 1s.

DIMENSIONS OF BIFURCATED, TUBULAR AND SEMI-TUBULAR RIVETS FOR GENERAL PURPOSES

No. 1885 : 1952. This new standard, which specifies the dimensions of oval head, flat countersunk head, and flat countersunk bevel head bifurcated rivets; oval head, flat countersunk head, and flat countersunk bevel head solid-drilled tubular rivets; and oval and flat countersunk head semi-tubular rivets. Illustrations of the rivets appear above the relevant tables of dimensions. Price 4s.

GENERAL REQUIREMENTS FOR ELECTRICAL EQUIPMENT AND INDICATING INSTRUMENTS FOR AIRCRAFT

No. G.100 : 1952. This standard deals with airworthiness requirements governing equipment and instruments, the details of which are covered in individual specifications in the "G" series of British Standards for aircraft electrical equipment and indicating instruments. The standard contains sections on requirements relating to operating conditions, materials and processes, particular design requirements and tests. Although the general requirements stipulated in the specification are for use in conjunction with specifications in the British Standards "G" series for aircraft materials and components, they may also be applicable to other aircraft electrical equipment or indicating instruments, where appropriate. Price 6s.

OXY-ACETYLENE WELDING OF HIGH-TEMPERATURE AND HIGH-PRESSURE PIPE-LINES

No. 1821 : 1952. This standard is the first of a series being prepared for the welding of pipe-lines and covers pipe-lines for service conditions in which the pressure exceeds 250 lb per square inch and/or the temperature exceeds 425 deg. Fah. (220 deg. Cent.). It lays down the conditions for shop and site welding of joints in such steel pipe-lines and fittings up to and including 20in diameter, and is divided into four parts.

The first part defines the parent metals and specifies the kinds of filler rods, welding technique, general precautions and qualifying tests for welders. Part 2 deals with butt joints and specifies the method of preparation and requirements for the completed welds. This section covers, not only plain butt welds, but also flanges and bends, both gusseted and cut-and-shut. The third section on branches includes details of preparations for the set-on and set-in types, and sleeve welds are covered in Part 4. Price 6s.

ELECTRICITY METERS

No. 37, Parts 1 and 2 : 1952. In this revision a new arrangement has been adopted, the requirements for various types of electricity meters being given in separate parts, preceded by a part dealing with general requirements applicable to all the types. Parts 1 and 2 (issued as a single document) are now available as follows:—Part 1, general clauses applicable to all types of motor meter; Part 2, single-phase, two-wire, whole-current, credit-type meters.

Further parts will be issued in due course and will deal with prepayment meters, polyphase meters, kilowatt demand meters, transformer-operated meters, d.c. meters, portable meters, and precision meters.

In the revision alterations have been made in the system of rating and in the number of ratings of single-phase, two-wire, whole-current meters. It is pointed out that, owing to the worldwide shortage of materials prevailing at the present time, some of the permissible limits of error are greater than would otherwise have been specified. Part 1 covers reference standards and definitions, and such matters as general construction, terminals diagram of connections, temperature rise, insulation, direction of rotation, nameplates, energy register and type tests. Part 2 covers standard ratings, dimensions, speed of rotation, power losses, limits of error, minimum running current, factors affecting change or error, excess current, facilities for adjustment, &c. Appendices deal with the protection of pivot and jewel in transit, methods of test, precautions necessary to ensure accurate performance in service, and location of nameplates. Price 4s.

Launches and Trial Trips

LISIEUX, cross-channel steamer; built by Forges et Chantiers de la Mediterranee, Le Havre, for the French Railways, Ltd.; length between perpendiculars 308ft 4in, breadth overall 45ft, depth moulded to "B" deck 24ft; displacement 2221 tons on 10ft 6in draught; accommodation for 1450 first-class and third-class passengers; two sets of Parsons h.p. and l.p. single-reduction geared turbines develop 22,000 s.h.p., to give a speed of 24 knots and take superheated steam at 426 lb per square inch and 705 deg. Fah., from two F.C.M. 47/60 water-tube boilers; two 300kW turbo generators and one 250kW diesel generator. Launch, February 26th.

DUCHESS OF ATHENS, oil tanker; built by the Furness Shipbuilding Company, Ltd., for the Trent Maritime Company, Ltd.; length between perpendiculars 525ft, breadth moulded 71ft, depth moulded 39ft 3in, deadweight 18,200 tons on 30ft 6in draught; Vickers-Doxford oil engine, six cylinders 670mm diameter by 2320mm combined stroke, 6600 b.h.p. at 115 r.p.m.: two Scotch boilers. Launch, May 14th.

WHEATFIELD, oil tanker; built by the Furness Shipbuilding Company, Ltd., for Eden Tankers, Ltd.; length between perpendiculars 496ft, breadth moulded 67ft 6in, depth moulded 36ft 5in; deadweight 16,500 tons on 29ft 1½in summer draught, speed 14 knots; twenty-seven cargo oil tanks, one pump room with two 400 tons per hour steam pumps, steam deck machinery; Fairfield-Doxford single-acting, two-stroke oil engine, five cylinders 670mm diameter by 2320mm combined stroke, 5500 b.h.p. at 112 r.p.m., two Scotch boilers, two 55kW steam generators and one 25kW diesel generator. Trial, May 19th.

CALTEX LIVERPOOL, oil tanker; built by R. and W. Hawthorn, Leslie and Co., Ltd., for the Overseas Tankship (U.K.), Ltd.; length overall 544ft 4in, breadth moulded 70ft, depth moulded 39ft 9in, deadweight 17,250 tons; one set of double-reduction geared turbines of 8200 s.h.p., taking steam at 450 lb per square inch and 750 deg. Fah., from two Yarrow three-drum water-tube boilers; two 400kW geared turbo generators, one 50kW diesel generator, two 50kW motor driven generators. Launch, May 22nd.

CEDRIC, refrigerated cargo liner; built by Harland and Wolff, Ltd., Belfast, for the Shaw Savill and Albion Company, Ltd.; length between perpendiculars 481ft, breadth moulded 69ft, depth moulded to shelter deck 41ft 6in; gross tonnage 10,800; two Harland and Wolff single-acting, two-stroke, opposed-piston diesel engines, cylinders 750mm diameter by 2000mm combined stroke, four 320kW diesel generators. Launch, May 22nd.

HOEGH RANGER, oil tanker; built by Joseph L. Thompson and Sons, Ltd., for Leif Hoegh and Co., Oslo; length between perpendiculars 475ft, breadth moulded 67ft 4½in, depth moulded 37ft 4in, deadweight 15,135 tons on 29ft draught; Doxford oil engine, four cylinders 670mm diameter by 2320mm combined stroke; service speed 12½ knots. Launch, May 23rd.

Contracts

THE BURNTISLAND SHIPBUILDING COMPANY, Ltd., is to build for William Cory and Son, Ltd., two self-trimming colliers propelled at 10½ knots by triple-expansion superheated steam engines supplied by the North-Eastern Marine Engineering Company (1938), Ltd. The main particulars of the ships are:—Length between perpendiculars 320ft, breadth 46ft, depth moulded 22ft 4in, and load draught 20ft.

DURING April the British Electricity Authority placed contracts for equipment for power stations, transforming stations and transmission lines amounting in the aggregate to £2,830,692. The principal contracts included:—Deptford East power station, reinforced concrete cable tunnels (A. Waddington and Son); East Yelland power station, near Barnstaple, one 30MW turbo-generator set (C. A. Parsons & Co. Ltd.); Portishead "B" power station, near Bristol, ash and dust-handling plant (B.V.C. Industrial Constructors, Ltd.); Goldington power station, Bedford, foundations (Mitchell Construction Company); Drakelow power station, Burton-on-Trent, control and instrument cables and accessories (British Insulated Callender's Cables Company, Ltd.); Ince power station, near Ellesmere Port, coal-handling plant (Simon Carves, Ltd.); Skelton Grange power station, Leeds, ash and dust-handling plant (Babcock and Wilcox, Ltd.); Fleetwood power station, pile foundations, access roads and main foundations (M. J. Gleeson (Contractors), Ltd.); Blackburn power station, high and low-pressure pipework and valves (Babcock and Wilcox, Ltd.); West Melton and Neepsend substations, Sheffield, 132kV, 2500MVA and 3500MVA switchgear (British Thomson-Houston Company, Ltd.).